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To the Graduate Council:

I am submitting herewith a dissertation written by Courtney Marie Monroe entitled "Knoxville Moves: Log-in and Get Mobile." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Kinesiology and Sport Studies.

Dixie L. Thompson, Major Professor

We have read this dissertation and recommend its acceptance:

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Knoxville Moves: Log-in and Get Mobile

A Dissertation Presented for the
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Abstract

This dissertation evaluated 1) the efficacy of a course-based Internet-technology intervention rooted in social cognitive theory (SCT) for increasing step counts in university faculty and staff, and 2) the effect of online social support tools on step counts among adults using a randomized control trial.

Thirty-six sedentary/insufficiently active university faculty and staff participated in an eight-week, Internet-delivered walking intervention. They received an Omron HJ-720ITC pedometer, personal step goals, and access to a Blackboard LearnTM website comprised of SCT-based features. Outcomes included daily steps, social support, self-regulation, self-efficacy, and outcome expectations. Participants significantly increased their average daily steps ($p < 0.001$) between baseline and week 1 by 1800. A similar increase in daily steps was observed between baseline and all other intervention weeks ($p < 0.001$). Social support and self-regulation significantly improved ($p < 0.001$). These findings helped inform the design of the second study.

In this second study, 63 sedentary/insufficiently active adults were randomly assigned to an online social support group or a no online social support group. Both groups received access to an Omron HJ-720ITC pedometer, individualized step goals, two websites, and a smartphone application for 12 weeks. The online social support group also had access to online social support tools. Outcomes included daily steps, self-regulation, social support, self-efficacy, and outcome expectations. Both groups significantly increased their daily steps ($p < 0.05$) from baseline (treatment: 4461.5 ± 1480.7 ; control: 4630.6 ± 1127.8) to 12 weeks (treatment: 5959.5 ± 1811.4 ; control: 7443.0 ± 2576.8), with no differences between groups. Family social support and exercise goal setting significantly increased in both groups ($p < 0.05$), with no difference between groups. A significant group by time interaction was found for exercise planning ($p <$

0.05) such that it increased in the control group and decreased in the treatment group. Self-efficacy significantly decreased in both groups ($p < 0.05$). Providing online social support tools to individuals randomly assigned to exercise groups does not result in enhanced daily steps or psychosocial outcomes when included as part of a technology-mediated walking intervention relative to an identical intervention without access to online social support tools.

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Part I

Introduction

According to the *2008 Physical Activity Guidelines for Americans*, adults should perform at least 150 minutes of moderate-intensity, or 75 minutes of vigorous-intensity aerobic physical activity each week (or an equivalent combination of moderate-and vigorous-intensity aerobic activity). Regularly engaging in physical activity promotes wellness and reduces the risk of many adverse health problems, including type 2 diabetes, obesity, heart disease, depression, high blood pressure, stroke, and some cancers.¹ Yet, in 2012, just 50.1% of United States (U.S.) adults engaged in regular moderate or vigorous physical activity, and nearly 30% of U.S. adults were inactive.² Several adverse health conditions are associated with a sedentary lifestyle, and the economic cost of physical inactivity among Americans is significant.^{1,3} Thus, the need for effective strategies to promote physical activity adoption and adherence among adults is apparent.

Physical activity interventions can be administered through various mediums, including technologies.^{4,5,6,7} The Internet and mobile phones represent two promising delivery methods for physical activity interventions targeting various populations and settings for several reasons. Easy access, convenience/flexibility of use, novelty, efficient real-time and asynchronous communication (e.g., facilitating immediate feedback and formation of social networks), a high degree of anonymity if desired, and the ability to easily distribute materials and reach a large number of people at a low cost are advantages of using such technologies to administer a behavior change intervention.⁸⁻¹⁰

Plus, 87% of U.S. adults use the Internet.¹¹ Relatively similar, high proportions (> 80%) of Internet users exist among adults belonging to various subgroups based on age, sex, race/ethnicity, urbanity, educational attainment, and household income.¹¹ Seniors (age 65 years and older) and persons who have not obtained a high school diploma represent the only two

subgroups that contain a lower proportion of Internet users. What is more, 88% of Internet users send or read electronic mail,¹² 78% watch or download online videos,¹³ 72% have looked online for health information within the past year,¹⁴ 52% have posted photos online,¹⁵ 46% send instant messages,¹² 32% read someone else's online journal or blog,¹² and 32% post comments to an online news group, website, blog, or photo site.¹² Likewise, 90% of U.S. adults have a mobile phone and 58% own a smartphone.¹⁶ Similar proportions (> 48%) of smartphone owners exist among adults belonging to various subgroups in terms of age, sex, race/ethnicity, urbanity, educational attainment, and household income.¹⁶ Seniors (age 65 years and older), persons who have not earned a high school diploma, low income earners, and persons living in a rural setting represent the only four subgroups that contain a lower proportion of smartphone owners. Mobile phone applications (software program designed to run on a mobile phone) represent a common feature of smartphones.¹⁷ In 2012, it was estimated that the number of downloaded mobile applications in 2013 will be between 56 billion and 82 billion.¹⁸ In fact, 84% of U.S. smartphone owners have downloaded an application to their phone, and 19% have downloaded a health management application. Exercise-related applications are the most popular type of health-related mobile application.¹⁹

Only a small number of smartphone-based physical activity promotion studies²⁰⁻²³ have measured physical activity behavior change (one of these studies²³ is ongoing). Two of the three completed studies yielded promising findings (one study²¹ used only a smartphone application and another study²² used both a smartphone application and the Internet to facilitate the delivery of a physical activity intervention). Conversely, findings from several reviews of studies centered on Internet-based physical activity behavior change interventions generally point to the promise of such interventions for positively impacting physical activity among various

populations.^{7,24-27} However, delivering Internet-based physical activity interventions can be complicated, often times requiring specialized skills and expertise (or access to expertise). The use of course-related Internet technology, such as Blackboard Learn™, represents one possible solution to this problem. Blackboard Learn™ is an established application at many higher education institutions, and it is also widely available via a free, publicly hosted online course creation and facilitation service called CourseSites™. The Blackboard Learn™ platform is easy to learn and has a number of features that can be used to create a comprehensive, interactive physical activity intervention. Select components of the Blackboard Learn™ Internet platform can also be accessed via the corresponding Blackboard Mobile Learn™ smartphone application.

To our knowledge, only four studies have used course-related Internet technology to deliver a physical activity intervention and none of these four studies utilized a corresponding smartphone application.²⁸⁻³¹ While all four studies reported promising findings in terms of physical activity, two^{28,29} of these studies relied upon self-reported measures of physical activity and three of them²⁸⁻³⁰ failed to measure intervention access/use (e.g., website log-ins; number of hits on sections within the website). Many Internet-based physical activity promotion studies are characterized by these methodological issues (i.e., used self-reported measures of physical activity and access/use or failed to measure access/use).^{7,24,25,27,32}

What is more, all four of the aforementioned course-related Internet technology studies used intervention components grounded in social cognitive theory,³³ but mixed results were found in terms of changes in presumed mediators of physical activity behavior change (i.e., social support, self-efficacy, outcome expectations, self-regulation).^{28,29,31} Factors related to the study design (e.g., instruments used to measure the psychosocial variables) and subject selection make it difficult to draw conclusions regarding these mixed findings.^{28,29,31} Other Internet-based,

as well as traditional physical activity promotion studies have also reported mixed findings when it comes to presumed mediators of physical activity behavior change (or failed to examine mediating constructs).³⁴⁻⁴⁰ Likewise, the design of Internet-based physical activity promotion studies makes it difficult to determine the degree to which individual intervention components and presumed mediators potentially affected behavioral outcomes and retention.^{7,24,28,29,31,32} Such information is important in order to design effective interventions while addressing attrition issues, which are relatively common in Internet-based physical activity-related studies.^{27,32,40-42}

An online community is one component that has the potential to improve participant engagement and retention, as well as favorably impact physical activity levels.^{7,31,42-47} An online community refers to a social unit that involves members who associate with each other as a group and use communication technologies to interact and exchange information in a real-time and/or asynchronous fashion (e.g., online message board, chat room, and instant message).⁴⁸ Such platforms can be used to give individuals the chance to share their challenges and successes, post pictures of their physical activities, provide direct encouragement, and offer helpful suggestions. That is, an online community may foster social support via a variety of methods, including social modeling, informational support, and emotional support among others.⁴⁹⁻⁵¹ Social support is considered to be a key theoretically-based behavior change element^{33,52,53} and has been positively linked to physical activity behavior, including physical activity maintenance, among different populations in several studies.^{40,50,54-59} It has also been positively linked to engagement in Internet-based health interventions.^{47,60,61} This connection may be important as increased engagement is positively related to increased intervention exposure, and in turn, behavior change. That is, increased engagement in an Internet-based intervention is an important factor in terms of the intervention's potential effectiveness.^{7,41,62-64}

Eseynbach et al.⁶⁵ carried out a systematic review of the literature centered on the effects of health-related online communities on health and social outcomes. They reported mixed findings for the impact of online communities on social support and found limited evidence of a favorable effect of online communities on smoking cessation and health-related outcomes (i.e., glycosylated hemoglobin, weight loss, and depression). However, they noted that the design of most of the reviewed studies made it impossible to draw definitive conclusions about the isolated impact of online communities. Additionally, many studies reported a lack of use of the online communities, making it difficult to show a potential effect. While some studies did find a positive relationship between online community use and measured outcomes, the direction of causation could not be determined.

A small number of quality randomized controlled trials have attempted to determine the isolated effect of an online community on various measured outcomes. For example, Glasgow et al.⁶⁴ examined the health-related impact of adding an online community to an information-based Internet nutrition intervention for adults with type 2 diabetes. They found a significant difference in perceived social support between the online community group and information-based control group after 10 months; however, they found no significant differences in behavioral, biologic, or other psychosocial outcomes. They reported that the use of the online community was relatively low at any given time, which may have reduced the effectiveness of the intervention.

Lorig et al.⁶⁶ used a randomized design to evaluate the combined effect of an online community and educational materials on different clinical indicators among individuals with chronic low-back pain. Unlike Glasgow et al.,⁶⁰ they observed high use of the online community over the course of 12 months (i.e., 2,000 total posted messages). Plus, the intervention group

significantly improved a number of clinical indicators relative to the control group (usual care and subscriptions to non-health-related magazines). Of course, the precise impact of the online community could not be determined due to the fact that educational materials were also part of the intervention.

On the other hand, Richardson et al.⁴² used a randomized controlled trial to examine the specific effect of an online community as part of an Internet-based walking intervention on step counts and attrition among a sample of adults who were overweight, had type 2 diabetes, and/or coronary artery disease. Participants were randomized to one of two groups. Both groups received the same intervention components (i.e., enhanced pedometers, access to a website where they could view their progress, goals, and motivational messages); one group also had access to an online community. While both groups significantly increased their average daily steps between baseline and the end of the 16-week intervention (approximately 2,000 steps/d for the entire sample), there were no significant differences in change in average daily steps between the groups across the intervention period. Likewise, there was no significant difference in baseline and post-intervention perceived social support between the two groups. These findings must be interpreted with caution though for a few reasons. The authors did not obtain physical activity information on days in which the pedometer was not worn. If participants were less active on these days, then their average daily step counts would have been falsely inflated. Since, the no online community group accumulated more of these non-wear days, average daily step counts may have been erroneously inflated in their favor. Also, the authors measured social support with a single-item question that had not been validated.

However, this study did report some promising findings in terms of engagement and retention.⁴² The online community group uploaded valid pedometer data on more days than the

no online community group and had a higher percentage of completers. Among participants who dropped out of the study, those in the no online community group dropped out earlier than those in the online community group. Plus, they found a significant, positive relationship between the number of posts to the online community forum and step counts, as well as the number of pages viewed and step counts.

To date, Monroe et al.³¹ have conducted the only course-related Internet technology physical activity promotion study (details contained in Part III of this document) in which an online community was part of the intervention and observed some findings that were similar to the findings of Richardson et al.⁴² For instance, they found a significant increase in average daily step counts of about 2,000 steps/d between baseline and each week of the eight-week intervention among their sample of adults, and 94% of the participants (n = 36/38) completed the study. Moreover, they observed a significant, positive relationship between total posts to the online community forum and step counts, as well as a borderline significant, positive relationship between self-reported frequency of viewing posts and step counts. They also found a significant, positive relationship between self-reported frequency of viewing posts and objectively measured total number of log-ins.

Unlike Richardson et al.,⁴² Monroe et al.³¹ found a significant increase in perceived social support among their sample from baseline; however, there were no significant relationships between perceived social support and any other measured outcomes. These latter results in particular must be interpreted with caution because the instrument used to measure social support targeted perceived social support from family and friends; thus, it may not have captured the sample's perceived social support from fellow participants who engaged in the online community. The use of a single-group pretest-posttest design represents another methodological

limitation of this study, making it impossible to determine the unique potential impact of the online community on social support, step counts, log-ins, and retention.

Based on the findings from this previous research centered on online communities, it is clear that three primary aspects are worth addressing. First, there is a need to continue to search for innovative and effective ways to facilitate engagement with online social support tools as an increase in the use of such tools may potentially lead to enhanced outcomes. Providing multiple online community options may be one way to successfully address this issue. For example, some participants may prefer to engage in an asynchronous discussion board, but others may prefer to participate in real-time chats. Some participants may perhaps be inclined to use both options. If only one option is presented, then an opportunity to maximize participant engagement in terms of online social support may be missed.⁶⁷ Similarly, providing more than one avenue to access online social support may be another way to stimulate increased use of online social support tools, and in turn, enhanced outcomes. For instance, participants could be given the option to access an online community via both a traditional computer and smartphone application.

As previously mentioned, little is known about how smartphone applications can be used to positively impact physical activity, particularly via social support. One eight-week study²¹ examined the impact of three different smartphone applications on physical activity behavior. Adult participants were randomly assigned to one of three groups. One group had access to an application focused on goal setting and problem solving. Another group had access to an application that targeted social support in part through an electronic message board. A third group had access to an application primarily focused on positive reinforcement. All three applications were designed to work jointly with a mobile phone's built-in accelerometer,

facilitating self-monitoring. The authors found significant mean increases in physical activity among all three groups across the intervention period. The social support group had the highest mean increase in weekly minutes of brisk walking (about 123 min/wk versus 71 min/wk and 105 min/wk for the goal setting/problem solving group and positive reinforcement group, respectively) and weekly minutes of total moderate-to-vigorous physical activity (about 257 min/wk versus 173 min/wk and 134 min/wk for the goal setting/problem solving group and positive reinforcement group, respectively). Thus, providing access to an electronic message board via a smartphone application may be an effective way to help promote physical activity.

A third way to possibly facilitate the use of online social support tools is by building upon preexisting social ties.⁴² If participants have a preexisting level of familiarity with each other, then they may be more apt to seek and provide social support through an online mechanism. For example, 68% of the participants in Monroe et al.'s³¹ course-related Internet technology physical activity promotion study made at least one post to the discussion board and 60% made multiple posts. The participants were faculty and staff at the same university; thus, some of them perhaps already had existing social ties with other participants and/or felt a sense of familiarity with other participants given that they were part of the same work setting. Such factors may partially explain why the discussion board remained relatively active throughout the study.

Moreover, another aspect that warrants further investigation is the possible mediating role social support plays when it comes to the potential effect that an online community has on program engagement, physical activity, and retention, using a validated and sensitive instrument to measure perceived social support. Thirdly, there is a general need to conduct well-designed,

online-based studies that will allow the unique impact of an online community on physical activity and other related outcomes to be highlighted.

Purpose

The purpose of this study is to conduct a 12-week randomized controlled trial, examining the collective impact of providing access to online social support tools as one part of a course-based Internet- and smartphone application-mediated intervention grounded in social cognitive theory on the following aspects in a sample of adults: step counts and presumed mediators (social support, self-efficacy, self-regulation, and outcome expectations) of physical activity behavior change.

Specific Aims

1. To compare the change in daily steps for participants who have access to online social support tools to participants who do not have access to these tools.
2. To compare changes in social support, self-efficacy, outcome expectations, and self-regulation from baseline to the end of the intervention for the two groups.

(Note: This purpose statement and these specific aims are addressed in Part IV of this dissertation. Part III was a pilot study completed in preparation for this randomized intervention.)

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Part II

Review of Literature

Physical Activity Status (United States Adults)

The National Health Interview Survey (NHIS) is an annual United States (U.S.) population-based survey, and as part of this survey, adults (≥ 18 years old) are asked to report their physical activity level.¹ According to the most up-to-date NHIS (2012) physical activity statistics, just 50.1% of adults met the aerobic physical activity guidelines set forth in the *2008 Physical Activity Guidelines for Americans* and 29.9% of adults were inactive.^{2,3} The collective physical activity status of U.S. adults is a public health concern because a lack of physical activity is associated with many adverse health conditions and poses a significant economic burden.^{2,4} Plus, a substantial proportion of Americans are missing out on the benefits of participating in a sufficient level of physical activity, including enhanced wellness and a reduced risk of various chronic diseases.¹ Given these facts, efforts to develop and implement effective physical activity promotion and adherence strategies are paramount.

Physical Activity Guidelines for Adults

Physical activity interventions targeting sedentary and insufficiently active individuals should naturally include a physical activity recommendation. The *2008 Physical Activity Guidelines for Americans* document was released in 2008 by the U.S. Department of Health and Human Services and contains the most recent physical activity recommendations for Americans.² These recommendations are guided by scientific evidence and provide information concerning the types, amount, and intensity of physical activity necessary to achieve many health benefits. Specific guidelines are provided for children and adolescents, adults, older adults, special subpopulations (e.g., pregnant women; persons with disabilities), and persons of various fitness levels.² According to the *2008 Physical Activity Guidelines for Americans*, adults (18 to 64 years old) should perform a minimum of 150 minutes/week of moderate-intensity aerobic

physical activity, or 75 minutes/week of vigorous-intensity aerobic physical activity (or an equivalent combination of moderate- and vigorous-intensity aerobic activity) in bouts of at least 10 minutes for substantial health benefits. This activity should be spread throughout the week if possible.² Engaging in 300 minutes/week of moderate-intensity aerobic physical activity or 150 minutes/week of vigorous-intensity aerobic physical activity (or an equivalent combination of moderate- and vigorous-intensity aerobic activity) affords additional and more extensive health benefits. Performing some physical activity is better than performing none. For example, inactive persons can gain health benefits (e.g., small increases in cardiorespiratory and muscular fitness) by engaging in one hour/week of moderate-intensity aerobic physical activity. Of note, walking is a good way to get aerobic physical activity because it has a low injury/medical risk and provides multiple health and fitness benefits.² In order to achieve weight loss or weight maintenance, many adults will have to perform a volume of physical activity beyond the minimum recommendation needed for most health benefits. Specifically, some persons may need to participate in 300 minutes/week or more of moderate-intensity aerobic physical activity for weight control. Baseline physical activity (typical light or sedentary activities of daily living) counts towards energy balance.²

In addition to aerobic activity, the *2008 Physical Activity Guidelines for Americans* recommend that adults do muscle-strengthening activities on two or more days/week, involving all major muscle groups. Such activities yield additional health benefits.² The *2008 Physical Activity Guidelines for Americans* states that flexibility exercises allow people to more easily perform activities that require great flexibility (e.g., dancing), but they have no known health benefits; therefore, no formal flexibility guidelines have been put forth.²

Pedometer-based Physical Activity Recommendations

Physical activity recommendations can also be delivered via the use of a step goal. This approach is characterized by a few notable aspects. In particular, a step goal has been shown to be memorable,^{5,6} and it requires the use of a pedometer, which constantly tracks and displays the number of steps taken by the user. Numerous studies have used a pedometer-based recommendation to help facilitate improvements in physical activity and health. Bravata et al.⁷ carried out a meta-analysis of 26 studies (8 randomized controlled trials and 18 observational studies) to ascertain the association between pedometer use and both physical activity and health outcomes among adults. They also highlighted key characteristics of the studies. Twenty-three studies used a step goal, and the average length of the studies was 18 ± 24 weeks. The majority of the participants were middle-aged, women, Caucasian, overweight, and insufficiently active (mean of 7473 ± 1385 steps/day). The findings from this meta-analysis indicated that pedometer-based interventions significantly increased physical activity by about 2,000 steps/day. The results also suggested that setting a step goal and using a step diary for self-monitoring were predictors of increases in physical activity. The three studies that used a pedometer in the absence of a step goal did not report significant improvements in physical activity in contrast to studies that used a step goal. What is more, pedometer use was significantly associated with a decrease in body mass index (BMI) and a 4 mmHg reduction in systolic blood pressure. Pedometer-based interventions can lead to favorable physical activity and health outcomes. In addition to the use of a pedometer, establishing a step goal and using a step diary for self-monitoring appear to be key motivating factors that can lead to improvements in physical activity.

The 10,000 steps/day goal represents one particularly popular pedometer-based physical activity recommendation^{8,9} in part of because research detailing its favorable relationship with health-related outcomes.¹⁰⁻²⁰ In particular, both cross-sectional and intervention-based studies targeting various populations have found a beneficial link between engaging in 10,000 steps/day and body fat percentage,^{10,14,16,17} waist circumference,^{10,14,15} body weight,¹⁴ BMI,^{10,11,14,16} systolic blood pressure,^{12,13,18,19} diastolic blood pressure,¹³ high-density lipoprotein cholesterol,²⁰ glucose tolerance,¹³ and insulin resistance.¹⁷ What is more, a number of physical activity promotion studies, in which the 10,000 steps/day goal was employed, have reported significant improvements in physical activity (steps/day).^{13,14,18,20-25} Of note, Hultquist et al.²¹ administered a four-week walking intervention after determining participants' baseline physical activity via a two-week, pedometer-based assessment. Fifty-eight sedentary women were randomly assigned to one of two groups. One group wore a sealed pedometer and was asked to briskly walk for 30 minutes per day on most, preferably all, days of the week (30-min group). The other group was asked to walk 10,000 steps/day (10K group), and they wore both a sealed pedometer and a second pedometer, which allowed them to track their steps. During the course of the intervention, the 10K group walked an average of $10,159 \pm 292$ steps/day, which was significantly greater than the average number of steps/day ($8,270 \pm 354$) the 30-min group accumulated. A 10,000 step/day goal and the use of a pedometer seemed to facilitate a greater increase in physical activity than a time-based prescription.

Despite its favorable association with physical activity and health, the 10,000 steps/day goal may not be achievable by everyone,^{8,9} and it does not consider activity intensity.²⁶ Marshall et al.²⁶ recently conducted a study in which they sought to translate the current moderate-intensity aerobic physical activity recommendations put forth in the *2008 Physical Activity*

*Guidelines for Americans*² into a pedometer-based step goal. A sample of 97 Latino men and women (mean age of 32.1 ± 10.6 yrs) completed four, six-minute walking bouts at 65, 80, 95, and 110 meters/minute. Energy expenditure was measured using a metabolic cart, steps were measured using a Yamax SW-200 pedometer, and step-rate cut points associated with moderate-intensity activity (3 metabolic equivalents or METS) were ascertained. The results suggested that walking at roughly a 100 steps/minute pace was equivalent to 3 METS; thus, walking a minimum of 3,000 steps in 30 minutes on five days per week (or three bouts of 1,000 steps in 10 minutes on five days each week) approximately aligns with the current moderate-intensity aerobic physical activity recommendations.^{2,26} This conclusion was consistent with the conclusion of an earlier study conducted by Tudor-Locke et al.²⁷ in which 50 young adults (25 men, mean age of 25.4 ± 4.7 yrs and 25 women, mean age of 23.6 ± 3.4 yrs) comprised the sample. It is worth mentioning that most healthy adults' preferred walking speed (3 miles per hour)²⁸ equates to 3 METS.²⁹

Several physical activity promotion studies have prescribed a similar type of step goal with success. In one study,³⁰ 50 adults were randomized to one of two groups after completing a one-week, baseline, pedometer-based activity assessment and the Scottish Physical Activity Questionnaire. Participants in the pedometer intervention group were given a progressively increasing step goal and ultimately asked to achieve 3,000 steps/day above their daily baseline step count on at least five days/week by the last week of the four-week intervention. Participants in the comparison group were prescribed a progressively increasing physical activity goal in terms of minutes of walking and asked to achieve 30 minutes/day on at least five days/week by week four. Both groups received suggestions about how they could increase their walking. Participants in the comparison group wore a sealed pedometer throughout the intervention.

During week 16 and week 52, 30 and 28 participants, respectively, wore a sealed pedometer for one week for a follow-up measurement. Participants from both groups participated in the follow-up. While both groups significantly increased daily steps from baseline to the end of the four-week intervention (by 4,593 steps/day for the intervention group and 2,206 steps/day for the comparison group) with no difference between groups, a significantly greater proportion of intervention group participants (77%) met their goal during week four versus the comparison group participants (54%). Daily steps were maintained from week four to week 16, but a significant reduction in daily steps was observed from week 16 to week 52. Both goal setting approaches successfully increased physical activity in the short-term, but this improvement could not be maintained over the long-term.

Houle et al.³¹ randomly assigned 65 cardiac rehabilitation patients to an experimental group or a usual care group. The experimental group participants received a pedometer, diary, and physical activity information. They were also given an exercise goal (walk 3,000 steps/day in 30 minutes) and engaged in six (one telephone and five face-to-face) consultations with a nurse over the course of the one-year study in which behavior change topics were addressed. The usual care group received standard advice and access to a center-based cardiac rehabilitation program. All participants' physical activity was measured using a one-week, blinded pedometer assessment at baseline, 3, 6, 9, and 12 months. Various cardiovascular risk factors were measured at baseline, 6, and 12 months. The experimental group significantly improved their average steps/day compared to the control group at 3 months (increase of $3,388 \pm 844$ steps/day versus $1,934 \pm 889$ steps/day) and 12 months (change in steps not reported). A significant reduction in waist circumference was found in the experimental group versus the control group at 6 months and 12 months, and a significant improvement in resting heart rate was also found in

the experimental group compared to the control group at 6 months. A pedometer-based intervention that uses a step goal similar to the current physical activity guidelines² is useful for improving steps, waist circumference, and resting heart rate among cardiac rehabilitation patients.

Another study³² had 82 participants (mean age of 52.8 ± 13 yrs) from a German community aim to accumulate 3,000 steps/day above their average daily baseline step count, which was determined by a one-week, pedometer-measured assessment. The intervention lasted 15 weeks. Participants received a pedometer and physical activity was promoted throughout the village via regular, optional events (e.g., morning walks and geocaching among others). The sample's average number of steps/day increased from $5,977 \pm 2,327$ steps/day at baseline to $9,091 \pm 3,007$ steps/day during the intervention. Over the course of the intervention, 54% of the participants achieved the 3,000 steps/day goal. The combination of a pedometer, 3,000 steps/day goal, and physical activity events appeared to result in improved physical activity among members of a German community.

Baker et al.³³ used a randomized controlled trial to determine the effect of a one-year, pedometer-based walking intervention on daily step counts and health-related outcomes in a group of 79 low-active Scottish men and women. Baseline step counts were determined by a one-week, pedometer-based assessment. Participants in the intervention group received a physical activity consultation focused on behavior change strategies and a pedometer. Their ultimate step goal was to achieve 3,000 steps/day above their baseline step count on at least five days/week. The control group was asked to maintain their typical walking levels. The initial part of the intervention lasted 12 weeks. Control group participants wore a sealed pedometer during the twelfth week of the study, so their step counts could be measured. Upon completion

of the 12 weeks, the intervention group received two more consultations and a leaflet focused on behavior change topics over the course of 36 additional weeks; whereas, the control group received the intervention that the intervention group received during the initial 12 weeks without the consultation.³⁴ A significant increase in daily steps was found in the intervention group (increase of 3,175 steps/day) relative to the control group at 12 weeks. Compared to the control group, a significantly greater percentage of intervention group participants (64% versus 10%) achieved the ultimate step goal over the initial 12-week portion of the intervention, which is in line with the current physical activity guidelines.^{2,33} However, both groups significantly increased their steps/day from the commencement of their respective walking interventions to 48 weeks. There was no significant difference between groups in the percentage of participants who reached their step goal one year after the start of their respective interventions (33% versus 28%). No significant changes were observed in terms of health outcomes.³⁴ A pedometer-based walking program that employed a goal of 3,000 steps/day on five days/week facilitated an increase in and a maintenance of previously low-active individuals' walking behavior regardless of whether physical activity consultations were used. It was not adequate to impact health outcomes.

Marshall et al.³⁵ recruited 348 Latina women from 12 community sites. The sites were block randomized to one of three step goal groups. One group was asked to use a self-selected step goal (SELF). A second group was asked to use a goal of 10,000 steps/day (FREQUENCY), and a third group used a step goal of 3,000 steps in 30 minutes (CADENCE). All participants engaged in a 12-week intervention, which involved the use of a pedometer and weekly group meetings led by a community leader. The group meetings focused on behavior change skills. A random sample of 60 participants in each condition wore an accelerometer so moderate-to-

vigorous physical activity (MVPA) could be measured. No significant difference was found among the three conditions in terms of post-intervention MVPA. The CADENCE group was significantly more likely to accumulate their MVPA in bouts lasting greater than 10 consecutive minutes compared to the other two groups. The proportion of participants in the CADENCE group who met the current physical activity guidelines² increased from 30% at the beginning of the intervention to 65% by the end of the intervention. This increase was greater than the other two groups, and the FREQUENCY condition had the fewest participants (35%) meeting the guidelines at the end of the intervention. A step cadence goal successfully helped Latina women accumulate MVPA in bouts of 10 minutes or more, which is in line with the national physical activity guidelines.²

Physical Activity Measurement and the Validity and Reliability of the Omron HJ-720ITC

Pedometer

While the primary function of pedometers is to objectively and continuously measure ambulatory activity in the form of step counts, some models also assess aerobic steps, time, aerobic time, distance, and/or energy expenditure.³⁶⁻³⁸ Pedometers are small, lightweight, portable, and practical devices that are typically worn at the waist; however, certain models can be worn in other locations, such as a front pants pocket or ankle among others.³⁶⁻³⁸ They utilize a sensing device (e.g., spring-suspended lever arm, magnetic reed proximity switch, pendulum, or piezoelectric accelerometer) as the basis for determining step counts.³⁶⁻³⁸

In addition to pedometers, physical activity can be measured via a variety of other techniques, such as accelerometer devices and self-report methods (e.g., questionnaires, surveys, diaries, and log).³⁹ Similar to pedometers, accelerometers are small, portable, and convenient devices that are usually worn at the waist.³⁶⁻³⁸ Accelerometers provide an objective measurement

of the frequency, intensity, and duration of physical activity.³⁶ One notable disadvantage of both accelerometers and pedometers is their inability to capture particular types of activities, such as swimming and cycling.³⁹ Conversely, self-report methods generally have the ability to capture both ambulatory and non-ambulatory activities and some self-report assessments also gather contextual information.⁴⁰ Additionally, most self-report methods can be easily administered to a large group of people at a low cost.^{39,41} Yet, self-report methods are prone to recall and response bias.^{40,41} Given the aforementioned facts, the combination of objective and subjective methods may be a preferable way to assess physical activity.^{39,42} Accelerometers are generally more expensive than pedometers,^{39,37,42} and unlike most pedometers, most accelerometer devices do not have a digital display, preventing users from instantly viewing and monitoring their physical activity;³⁷ thus, when it comes to walking-based physical activity promotion studies, the use of both pedometers and self-report methods may be a particularly useful physical activity measurement approach.³⁹

Findings from several studies,⁴³⁻⁵⁶ as well as reviews of studies,^{57,58} point to the validity and reliability of various pedometers for measuring step counts in adults of varying weight status. One noteworthy pedometer is the Omron HJ-720ITC (Omron Healthcare, Inc., Lake Forest, IL). It can be worn in an upper front shirt pocket, a front pants pocket, in a bag, or on a belt or waistband.⁵⁹ It contains dual accelerometer sensors positioned at 90° to each other, so it can be oriented horizontally or vertically as long as the front side of the device is not placed at an angle of less than 60° of vertical.^{37,59} It allows a user's weight and stride length to be entered, stores up to 41 days of data, displays the most recent seven days of data, and has roughly a six-month battery life.^{37,59} Variables it assesses include total steps, aerobic steps (≥ 60 steps/minute

pace for ≥ 10 -minutes continuously), aerobic time in minutes, calories and fat grams burned, and distance.⁵⁹ It does not begin recording steps until there has been four seconds of movement.

This technologically advanced device is Internet technology compatible, meaning users can connect it to their personal computer using a USB cable and subsequently upload their stored activity data to their personal account on a corresponding website (www.omronfitness.com).

The data automatically uploads to the website through the Omron Fitness software driver, which users can download for free from www.omronfitness.com. Users access their own account using their personal username and password. The Omron Fitness website summarizes and displays users' data via graphs and tables, allowing them to track progress towards their goals. What is more, Omron Health Management software is provided along with the Omron HJ-720ITC pedometer, creating another data management option. Once the software is installed on a personal computer, users can create a personal account. Then, they can download their data to their account by connecting the pedometer to their computer with a USB cable and subsequently clicking a download button. Graphs and tables are used to summarize and present their data.

A recent study by Rider et al.⁶⁰ ascertained the Omron HJ-720ITC's feasibility for use in physical activity interventions by analyzing data obtained from 28 adults who participated in an eight-week health behavior change randomized controlled trial. Specifically, participants were randomized to one of two groups. Both groups received a physical activity prescription (gradually increase moderate-to-vigorous physical activity to ≥ 40 minutes/day on five days/week). They were encouraged to do brisk walking and wore the Omron HJ-720ITC pedometer. Data from the pedometer was downloaded to a computer every two weeks by the investigators. One group also received a prescription to reduce television watching to ≤ 10 hours/week. Data from the two groups was combined for the statistical analyses. Daily step

increased from baseline to week eight ($5,530 \pm 2,364$ to $7,283 \pm 2,747$). Aerobic steps increased from baseline to week eight ($662 \pm 1,008$ to $2,514 \pm 2,105$). Using aerobics steps and aerobic time data, the authors were also able to determine aerobic steps/minute for continuous bouts of walking lasting at least 10 minutes. Participants exceeded 100 steps/minute (moderate-intensity) for 89% of their aerobic minutes. The authors concluded that the pedometer was feasible for use in face-to-face lifestyle interventions conducted in a small group setting, and it was able to detect the increase in daily steps over the course of a short-duration lifestyle intervention.

The Omron HJ-720ITC pedometer has generally been shown to be both valid and reliable for measuring step counts.⁵⁴⁻⁵⁶ Holbrook et al.⁵⁴ examined the validity and reliability of this pedometer to measure step counts during prescribed and self-paced walking conditions. Thirty-four university students (17 males and 17 females) completed three, separate, 100-meter walking conditions on an outdoor track. They walked at randomized, prescribed speeds of two miles per hour, three miles per hour, and four miles per hour. They wore pedometers on the waistband at the right hip (RH), left hip (LH), and midback (MB). Participants also wore pedometers in the right (RP) and left (LP) pants pockets, as well as a backpack worn on the shoulders (BP). In addition, 31 university students (18 males and 13 females) wore pedometers in the same previously mentioned locations and completed a one-mile walk at a self-selected pace on a course consisting of flat concrete walking, stair climbing and descent, grass walking, and stops at road crossings. An investigator walked behind each participant and used a hand tally counter to measure step counts, which served as the criterion measure for all walking trials. Reliability was examined for each separate condition (prescribed and self-paced) by randomly selecting six pedometers (one for each site) from a collection of 24 devices. Absolute percent error (APE) ranged from 1.1% to 3.5% across prescribed walking speeds and mounting

locations. The combination of the BP position and slow walking trials yielded the largest APE. In terms of the self-paced walking condition, APE ranged from 1.0% to 2.0%. Low coefficient of variation values for both conditions ($\leq 3.3\%$) provided evidence for interdevice reliability. The Omron HJ-720 ITC pedometer validly and reliably measured step counts during prescribed and self-paced walking conditions in healthy and overweight adults.

Zhu et al.⁵⁵ asked forty subjects (20 men and 20 women) to wear 10 Omron HJ-720ITC pedometers (front left waist, front right waist, back left waist, back right waist, front pants pockets, left shirt pocket, inside a bag carried on the left side, around the neck as a pendant, and in a backpack), two Yamax Digi-Walker SW-200 (Yamasa Tokei Keikie Co, Ltd., Tokyo, Japan) pedometers on the waist (front left and right), and a Dynastream AMP 331 (Dynastream Innovations Inc., Cochrane, Alberta, Canada) activity monitor on the right ankle during three different conditions. During one condition, they walked for 100 steps on a flat sidewalk 10 times (condition 1). During a second condition, the subjects walked up and down three flights of stairs (condition 2). A research assistant followed the subjects, manually counting the steps with a clicker during both conditions. Then, the subjects walked at a self-selected pace in a mixed situation for the third condition, consisting of flat sidewalks, grass, a hill, and a ramp in a building (condition 3). The Omron HJ-720ITC pedometers measured step counts reliably and with accuracy (most of the mean absolute error percentages were $< 3\%$) during condition 1 and stair-climbing across most locations (a small decline in accuracy was observed in the front pants pocket locations) and all BMI categories. These pedometers also accurately captured steps across locations and BMI categories during condition 3 and while walking down the stairs. The Omron HJ-720 ITC provided a valid and reliable measure of steps across weight status groups and different locations during continuous walking.

Another study⁵⁶ divided a sample of 102 adults into two age groups (20 to 49 years and 50-80 years). Fifty-three participants (32.9 ± 10.8 years) and 49 participants (65.4 ± 6.9 years) comprised the former and latter groups, respectively. They wore an Omron HJ-720ITCF pedometer on the waist at the midline of their left thigh and a Kenz Lifecorder EX pedometer (Suzuken Co. Ltd., Nagoya, Japan) on the waist at the midline of the right thigh. They walked on a treadmill at five different fixed speeds (ranging from 53.6 meters/minute to 107.2 meters/minute) for five minutes at each speed. They also performed an overground walking condition, walking one lap around an indoor track at three self-selected speeds (< normal, normal, and > normal). Actual steps during the aforementioned conditions were measured by a researcher with a hand-tally counter. Moreover, a random subsample of 20 participants wore the Lifecorder pedometer in the same position as the laboratory conditions and a New Lifestyles NL-1000 (New Lifestyles, Inc., Warminster, PA) pedometer on the waist at the midline of the other thigh during a 24-hour period (except when sleeping and in contact with water). Then, they repeated this condition during another 24-hour period, but they wore the Omron pedometer in the same position as the laboratory condition instead of the Lifecorder. The New Lifestyles pedometer served as a standard for comparison. There were no significant differences between the Omron-measured steps and the tallied steps for either age group across treadmill speeds and overground, self-selected walking speeds; whereas, significant differences were found between the Lifecorder-measured steps and the tallied steps during some of the treadmill and overground trials. In terms of the 24-hour condition, the Omron pedometer significantly underestimated steps for the younger and older age groups with a MES of 949.1 (597.8, 1300.4) and 612.9 (34.4, 1191.4), respectively. Overall, the findings suggested that both the Omron HJ-720ITC

pedometer and the Lifecorder pedometer appear to be suitable devices for measuring walking behavior; however, there are differences in daily total steps for these devices.

Findings from Silcott et al.'s⁶¹ study are in line with Dondzila et al.'s⁵⁶ latter conclusion. They showed 62 adults (31 males and 31 females) how to wear an Omron HJ-720ITC pedometer on the waist in the midline of the right thigh, in the right pants pocket, and around the neck. Participants were also shown how to wear the Yamax SW-200 on the waist in the midline of the left thigh, as well as the criterion pedometer (StepWatch-3) on the lateral side of the right ankle. Participants were instructed to wear all pedometers for a 24-hour period during waking hours (except when showering). Across all three Omron locations, the Omron HJ-720ITC significantly underestimated the steps per day in normal weight ($n = 19$), overweight ($n = 23$), and obese ($n = 20$) participants versus the StepWatch-3. The Omron pants pocket location was the most accurate among the three Omron locations, registering 68%, 70%, and 65% of the StepWatch-3 determined steps in the normal weight, overweight, and obese groups, respectively. While BMI did not affect the step count recorded by the Omron pedometer in the pants pocket location, the other two Omron locations were significantly less accurate in the obese group compared to the other two weight status groups. The Omron pedometers showed significantly more error compared to the Yamax pedometer in normal weight and overweight individuals. The authors surmised that the Omron HJ-720ITC's four-second filter may result in the failure to detect steps taken during intermittent lifestyle activities, and this factor may have partially contributed to Omron's underestimation of steps in a free-living condition. They also explained that the tilt angle may not be affected in the pocket position, which may partially explain why BMI did not impact the steps recorded by the Omron pedometer in the pants pocket location. The authors concluded that the Omron HJ-720ITC still can be a useful device for interventions that prescribe continuous

bouts of walking, but investigators should realize that it does not capture all steps that are taken during the day. It is important to note that the most frequently occurring walking bout duration in nondisabled, free-living adults is between 10 and 20 seconds (26% of total walking bouts).⁶²

Social Cognitive Theory Overview

Constructing behavior change interventions requires an understanding of human behavior.⁶³ For example, multiple behavior change theories exist, which can be used to guide the design of a physical activity intervention.⁶⁴ Albert Bandura's social cognitive theory (SCT) is one example of a behavior change theoretical model that has frequently been applied to the promotion of physical activity.⁶⁴ It proposes that behavior and behavior change are determined by interactions among personal factors, environmental factors, and characteristics of the actual behavior.^{64,65} These three classes of determinants are reciprocally influential, meaning each one may impact or be impacted by the other two.^{64,65} However, the strength of the impact of these three classes of determinants is not necessarily equivalent; their impact varies for different activities and circumstances.⁶⁵

In terms of physical activity, the intensity of the activity and the benefits yielded from it are two examples of behavioral factors that can ultimately play a role in behavior change efforts based on the SCT.⁶⁴ Moreover, the SCT posits that both physical and social environmental factors can influence behavior.⁶⁶ For example, the safety of a neighborhood, the availability of green space for physical activity, and receiving encouragement to be active from a family member are factors that may ultimately influence physical activity behavior.⁶⁴ In the context of the SCT, personal factors include cognitive, affective, and biological characteristics.⁶⁵ For instance, demographic variables (e.g., race/ethnicity, sex, and age) and psychosocial variables

(e.g., self-efficacy, self-regulation, and outcome expectations) represent individual factors that may ultimately impact physical activity behavior.⁶⁷

Self-efficacy is an integral SCT concept and defined as confidence in one's ability to successfully carry out a given behavior.^{64,68} Thus, exercise self-efficacy refers to a person's belief in his/her ability to successfully lead a physically active lifestyle under specific circumstances or in the face of different obstacles (e.g., feeling stressed; bad weather).^{69,70}

According to the SCT, self-efficacy can be shaped by the following four sources of information: mastery experiences, social modeling, verbal persuasion, and physiological and affective states.⁶⁵

Personal mastery experiences are considered to be the most influential informational source of the four sources.⁶⁵ It refers to past experiences with a given behavior.⁶⁵ For example, successfully engaging in physical activity in the past would be purported to help foster a strong sense of exercise self-efficacy, and in turn, positively impact physical activity behavior; whereas, failed past physical activity attempts may exert the opposite influence.^{65,70} Social modeling refers to obtaining vicarious experience by observing the preferred behavior.^{65,70} The SCT posits that individuals gauge their capabilities in relation to the performance of others who are considered to be similar to them. Thus, observing or visualizing successful engagement in physical activity by persons deemed to be similar to oneself can theoretically enhance exercise self-efficacy and subsequently physical activity behavior; conversely, the opposite result can occur when individuals observe others perceived to be similar to them fail to lead a physically active lifestyle despite a high level of effort. When individuals have had limited past experiences with a given behavior, they may rely on social modeling to a greater extent to get an idea of their own capabilities.⁶⁵ Moreover, the SCT states that realistic verbal persuasion (i.e., positive reinforcement from significant others or people with credibility for a given circumstance and

self-talk) can favorably influence self-efficacy beliefs and subsequent performance of a given behavior.^{65,70} For instance, verbally persuading individuals that they are capable of engaging in a physically active lifestyle can theoretically help boost exercise self-efficacy and facilitate an enhanced effort to be physically active.⁶⁵ Physiological and affective states also are purported to influence people's evaluation of their own capabilities and are particularly key when it comes to the area of health functioning.⁶⁵ Correctly interpreting physiological indicators and controlling emotions to subjective threats are two examples of ways to positively alter self-efficacy.⁶⁵ For instance, a rapid heart rate during physical activity may be interpreted as a negative symptom (i.e., the activity is unsafe) or a positive symptom (i.e., challenging the heart to become more fit).⁷⁰ Similarly, the affectivity elicited during physical activity can be interpreted in a positive or negative fashion.⁶⁵ Based on the SCT, individuals draw upon these informational sources when they encounter a given task, evaluating their personal capabilities to successfully perform the task. Those persons who possess a high sense of self-efficacy for a perceived difficult task are hypothesized to approach it as a challenge that can be conquered, putting forth a high level of effort, persevering in the face of obstacles, and developing an intrinsic interest in it over time.^{65,70}

Self-efficacy is purported to influence behavior directly and indirectly through the constructs of outcome expectations and self-regulation.⁶⁹ Outcome expectations are the expected consequences a given behavior will likely generate and can be classified as physical (e.g., pleasant or negative sensory experiences and material benefits and losses), social (e.g., social approval or disapproval), and self-evaluative (e.g., personal positive and negative reactions).^{65,69} The SCT conjectures that a causal relationship exists between self-efficacy and outcome expectations.⁶⁵ More specifically, the outcomes people expect to occur from performing a given behavior depend primarily on their confidence in their ability to perform that behavior.⁶⁵ For

example, if individuals have a high exercise self-efficacy, then they would expect to experience the benefits of physical activity, and in turn, increase their level of physical activity.⁶⁷ On the other hand, possessing low exercise self-efficacy would facilitate negative outcome expectations (e.g., sweating or discomfort) and a subsequent reluctance to engage in a higher level of physical activity.⁷¹ In addition, it is possible for individuals to have an awareness of positive outcome expectations, but decide not to perform a particular behavior due to their low self-efficacy or lack of confidence in their ability to carry out that behavior adequately enough to obtain the desired outcomes.⁶⁸ Since, the outcome expectations individuals expect to experience as a result of performing a certain behavior are very reliant upon self-efficacy evaluations, they may not account for much additional variance in behavior after taking self-efficacy into account (particularly when the outcomes are closely linked to the behavior). However, this notion does not mean that outcome expectations are insignificant when it comes to behavior. Bandura⁶⁸ clearly states that because people recognize that outcomes are contingent upon the satisfactoriness of their performance, they depend on self-efficacy beliefs to guide their decision about whether or not to pursue a behavior. Furthermore, the extent to which individuals value given outcomes is also influential. That is, valuing a positive outcome will facilitate engagement in a given behavior to a greater extent than an outcome that is thought to be of little worth.⁷¹

Bandura^{65,72} also delineates the nature of the influence of self-efficacy on self-regulation, which is another SCT construct. That is, those who possess a strong sense of self-efficacy will be more inclined to adopt self-regulation strategies targeting a particular behavior. Given the relationship between self-efficacy and outcome expectations, the SCT naturally posits that expecting to experience positive outcome expectations can also facilitate self-regulation, and in turn, successful engagement in a given behavior.⁶⁷ In terms of health, self-regulation simply

refers to a process in which individuals exert their influence on their own health habits.⁷³ More specifically, it is characterized by the premise that people have self-reflective and self-reactive capabilities that allow them to wield some power over their emotions, thoughts, motivation, and actions.⁷² It is considered to be a particularly essential construct when it comes to adopting and maintaining a physically active lifestyle.⁶⁵

Self-regulation works via a set of psychological subfunctions that can be developed and implemented to foster the desired behavior.⁷² One such subfunction involves self-monitoring the behavior, the context in which it takes place, and the short-term and long-term effects that are produced.⁷² In order for self-monitoring to be effective, the SCT details various factors that must be considered, including temporal proximity (i.e., regular self-monitoring), informativeness of performance feedback (i.e., must have a clear idea of progress), motivation level (i.e., must possess a desire to change the behavior being monitored), valence of the behavior (i.e., valuing a behavior will elicit heightened self-reactions), and focusing on successes.⁷² Self-monitoring helps inform personal goals and provides the information necessary to evaluate progress towards them.⁷² Both short-term and long-term goals should be set. Long-term goals reflect the overall framework for behavior change, but short-term goals are necessary to provide guidance and motivation in the present.⁶⁹ Establishing strategies or a plan to achieve such goals is also important.⁷³ Both a knowledge of one's performance and personal standards are necessary to form the basis for self-evaluative reactions.⁷² The SCT also notes that establishing personally meaningful incentives for reaching milestones represents another key self-regulatory concept.⁷³ Incentives can be self-evaluative reactions (e.g., self-satisfaction) or tangible (e.g., recreational activities).⁷² Setting step count goals based on information gathered from a baseline self-monitoring period, devising strategies to achieve those goals (e.g., enlisting a walking-based

lifestyle approach), continually monitoring progress towards them (e.g., tracking steps with a pedometer and recording them in an activity log), and establishing personal rewards for the achievement of milestones (e.g. go to a movie) is one example of how to implement such concepts.

Social support is another influential variable that is part of the SCT model and has the potential to directly influence behavior, as well as indirectly influence behavior via the three previously described psychosocial variables (self-efficacy, outcome expectations, and self-regulation).^{65,67} Social support is generally defined as the perceived support received from others⁶⁵ or the helpful resources given by another person.⁷⁴ It can further be classified into different types, including informational, tangible, esteem, network, emotional support, and social modeling.^{65,75} Briefly, informational support refers to providing advice, referring individuals to appropriate resources, helping individuals view a situation from a different perspective, or teaching individuals new knowledge and skills.⁷⁵ For example, an exercise professional might educate an individual about the benefits of exercise or refer him/her to a particular exercise class. Tangible support is characterized by providing an actual service or resource.⁷⁵ For instance, offering to watch one's children so he/she can perform a workout or loaning someone exercise equipment are two examples of tangible support. Providing compliments, validating feelings, and helping individuals avoid self-blame are actions that typify esteem support.⁷⁵ Network support takes place when someone helps connect an individual with others or offers to be with the individual.⁷⁵ For example, someone might invite a friend to walk with him/her during lunch breaks. Emotional support involves encouragement, listening, empathy, sympathy, and/or closeness.⁷⁵ Asking about how someone's physical activity progress, and listening to their triumphs and frustrations with a physical activity program are two examples of emotional

support. Social modeling has been described previously. Even though the SCT does not rule out the influence of social support on other psychosocial constructs, Bandura⁶⁵ argues that its impact on behavior primarily operates through the self-efficacy construct. In other words, enlisting the types of social support previously detailed is purported to foster an increase in perceived social support, and in turn, engagement in a desired behavior largely by way of enhanced self-efficacy.⁶⁵

Measurement of Exercise-related Self-efficacy, Outcome Expectations, Self-regulation, and Social Support

Asking participants to rate their level of confidence for overcoming common physical activity barriers is frequently the way in which exercise self-efficacy is measured.⁷⁶ McAuley's⁷⁷ Barriers Self-efficacy scale assesses individuals' exercise self-efficacy in this way, and its development was guided by Bandura's SCT.⁶⁴ It contains 13 items that measure participants' perceived ability to exercise three times a week for 40 minutes for the next three months when confronted with barriers to participating in exercise (e.g., bad weather; personal stress). Participants rate the items on an 11-point scale ranging from 0 (not at all confident) to 10 (highly confident). The item scores are summed and the total score is divided by the total number of items, yielding the final self-efficacy for exercise score. Higher scores indicate a stronger perceived ability to exercise when faced with barriers to exercise. This instrument was initially developed for sedentary adults who engaged in an outpatient exercise program.⁷⁸ It has demonstrated adequate validity and reliability when used to measure exercise self-efficacy among sedentary, middle-aged, men and women.^{77,79}

The Multidimensional Outcome Expectations for Exercise Scale (MOEES),⁸⁰ which is designed to measure individuals' outcome expectations about the benefits of exercise, also has a

solid foundation in Bandura's SCT.⁶⁵ Most health-related outcome expectation measures are single-dimensional;⁸⁰ however, the MOEES contains 15 items that encompass the three outcome expectation subdomains (physical, social, and self-evaluative outcome expectations) highlighted in Bandura's SCT.^{65,80} Participants rate each item on a 5-point scale ranging from 1 (strongly disagree) to 5 (strong agree). The items belonging to each subscale are summed, resulting in three separate total scores (one for each subdomain). Higher scores reflect stronger beliefs in the subdomain-specific benefits of exercise. Improvement of overall body functioning, enhanced companionship, and feeling a sense of accomplishment are examples of topics that are addressed in each subdomain (physical, social, and self-evaluative, respectively). When the MOEES was used to measure middle-aged and older adults' outcome expectations for exercise, it demonstrated acceptable construct validity, as well as discriminant validity among the three subscales. All three subscales also showed good reliability.⁸⁰

In order to assess self-regulation skills for exercise described by Bandura⁶⁵ (e.g., goal setting, self-monitoring, planning), Rovniak et al.⁸¹ designed the Exercise Goal-Setting scale (EGS) and the Exercise Planning and Scheduling scale (EPS). Each respective questionnaire contains 10 items that individuals rate on a 5-point scale ranging from 1 (does not describe) to 5 (describes completely). For instance, "I often set exercise goals" and "I schedule my exercise at specific times each week" are items from the EGS and EPS, respectively. The item scores are summed to obtain a total score for each questionnaire. Higher scores indicate a stronger propensity for exercise goal setting and exercise planning. Both questionnaires have been found to be a valid and reliable measure of self-regulation for exercise in adults.⁸¹

Moreover, Sallis et al.⁸² sought to develop a measure of perceived social support that specifically targeted exercise behaviors, and thus, constructed the Family and Friend Support for

Exercise Habits scale. This questionnaire contains 13 items. Individuals rate each item twice (once for perceived social support for exercise from family and once for perceived social support for exercise from friends) on a 5-point scale ranging from 1 (none) to 5 (very often). For example, one item states, “During the past three months, my family (or friends) exercised with me.” The item scores are summed to obtain a total score for each questionnaire. Higher scores indicate a stronger sense of social support for exercise from family and friends. This measure is considered to be both a valid and reliable way of assessing perceived social support for exercise in adults.^{82,83}

Evidence of Relationships between Physical Activity and Self-efficacy, Outcome

Expectations, Self-regulation, and Social Support for Physical Activity

Numerous studies have detailed the relationships between physical activity and self-efficacy, outcome expectations, self-regulation, and social support. In particular, reviews of literature centered on factors linked to exercise behavior,^{7,84-87,88} have found self-efficacy, social support, and self-regulation to generally be consistent predictors of physical activity behavior in adults. For example, one study⁸⁹ randomly assigned 63 sedentary, middle-aged men and women to one of three groups for a two-year period (home-based high-intensity exercise, home-based low-intensity exercise, and class-based high-intensity exercise). Self-efficacy was assessed two weeks into the study and at one year via a 14-item scale, which asks respondents to rate their level of confidence that they would continue to exercise in the face of potential barriers. In order to measure exercise behavior, participants completed exercise logs and participation rates were based on the volume of exercise completed relative to the participants’ prescription. The following three phases of exercise were examined: adoption (months 1-6), early maintenance (months 7-12) and long-term maintenance (year two). Baseline self-efficacy only significantly

predicted early exercise adherence (adoption phase). Higher year-one self-efficacy predicted greater exercise adherence during the second year in the home-based conditions. The authors concluded that individuals' initial self-efficacy may play a more influential role in the earlier stages of exercise participation and become a less important regulator of behavior as the behavior becomes more routine. A home-based exercise format may facilitate greater exercise adherence than a class-based format in part because it eliminates barriers individuals must overcome (e.g., travel, lack of time) relative to a class format.

Sallis et al.⁹⁰ analyzed data obtained from the Stanford Community Health Survey, which was administered at baseline and one year later to a randomly selected cohort of 652 men and 759 women between the ages of 20 and 74 in the California area. The subjects' level of moderate-intensity physical activity and vigorous-intensity physical activity were assessed as part of the survey. Four of the survey questions asked the participants to rate their self-confidence in their ability to engage in physical activity. These questions measured their exercise self-efficacy, and only their baseline responses were used in the analyses. Exercise self-efficacy predicted adoption of vigorous physical activity and maintenance of moderate physical activity. Men were more likely to adopt vigorous physical activity and women were more likely to maintain moderate physical activity. The findings support the importance of self-efficacy as a determinant of physical activity habits in a community sample. While self-efficacy was not a predictor of vigorous physical activity maintenance and moderate physical activity adoption, a more refined measure of self-efficacy may have yielded different results.

McAuley et al.⁹¹ aimed to assess the relationship between exercise levels of sedentary, middle-aged, females and self-efficacy. Fifty-eight women engaged in an eight-week aerobic fitness program (twice weekly, one-hour aerobic class led by a trained fitness instructor). Their

exercise self-efficacy was assessed at the end of the program via a scale comprised of items targeting the participants' beliefs in their capabilities to successfully continue to exercise in the face of potential barriers. Follow-up questions two months after the cessation of the program were also administered. These questions asked the participants to indicate the frequency and duration of their exercise and whether they perceived themselves to be exercising on a regular basis. Post-program self-efficacy was significantly and positively correlated with perceived regularity and duration of exercise. Such findings suggested that self-efficacy may be a key component of exercise adherence after the termination of a structured program.

Another study⁹² analyzed questionnaire responses from 2,053 Californian adults. The questionnaire was mailed to the participants and contained items that assessed respondents' level of walking and exercise self-efficacy among other variables. Self-efficacy was significantly and positively correlated with walking behavior among the sample of respondents (excluding those with long-term illness or injury). When respondents who reported engaging in vigorous exercise three or more times per week were also excluded from the analysis, self-efficacy was still significantly and positively correlated with walking. Based on these results, the authors suggested that physical activity interventions targeting sedentary adults should aim to increase perceived exercise self-efficacy.

Sternfeld et al.⁹³ administered a mailed survey to a random sample of 2,662 ethnically and educationally diverse women in order to assess the relationships between different domains of physical activity and psychosocial variables. A modified version of the Baecke questionnaire was used to measure frequency of domain-specific activities. Participants also completed three items related to the degree to which friends or family gave support for exercise behavior, and these items served as a measure of social support. This variable was associated with higher

levels of sports/exercise participation, indicating the potential influential role of social support in terms of planned, structured physical activities.

Likewise, Eyler et al.⁹⁴ conducted a telephone survey of 2,819 middle-aged and older-aged racially and racially/ethnically diverse women in order to examine the relationship between social support and physical activity. Social support for physical activity was measured via a previously validated questionnaire. Participants also responded to a series of questions about lifestyle physical activity. Participants who reported high levels of social support were significantly more likely to have completed 300 minutes of weekly activity compared to those who reported receiving no/low social support. The results suggest that enhancing social support may be an important aspect of physical activity interventions targeting sedentary women of different racial/ethnic backgrounds.

Addy et al.⁹⁵ conducted telephone interviews among a sample of 1,194 randomly selected adults from a predominantly rural southeastern county in the United States. Twenty-six survey items measured perceived supports and barriers for physical activity in the neighborhood and community. Physical activity was measured via the 2001 Behavioral Risk Factor Surveillance System physical activity module. Respondents were classified as active (≥ 30 minutes of moderate activity on \geq five days/week, or ≥ 20 minutes of vigorous activity on ≥ 3 days/week), insufficiently active (lower levels than active), or inactive (no moderate or vigorous activity). They were also classified as regular walkers (≥ 30 minutes on ≥ 5 days/week), irregular walkers (lower levels than regular walkers), or nonwalkers (no walking for ≥ 10 minutes at a time). Having a physically active neighbor was associated with increased walking behavior. Observing a neighbor walking is a form of social modeling,⁶⁴ and a physically active neighbor can also provide a source for social comparison and serve as a walking partner. Thus, the authors

concluded that helping individuals become aware of opportunities to connect with others who are interested in physical activity may be an effective strategy for future community-based interventions.

Another study⁹⁶ described the relationship between social support and exercise adherence in a sample of 282 women (mean age = 48.2 ± 14.4 years) engaging in community exercise programs. The programs were offered three times per week, and each class had an aerobic component during which the participants exercised continuously at the target heart rate for at least 20 minutes. Participants completed a questionnaire during the second week of the program that included a measure of social support (Social Provisions Scale), and they completed a follow-up questionnaire at the end of the fifth week of the program. Attendance records were used as a proxy of exercise behavior and collected after the fifth week of the program. Participants attended an average of 74% of the classes over the five-week study period. Seventy-five percent of the participants reported that their significant others believed it was important to exercise. The follow-up questionnaire revealed that 68% of the participants felt the instructor was very important to their program attendance, and an equal proportion of participants reported that other class members were important to their attendance. The authors stated that the findings suggest that social support from a woman's partner and/or friends may enhance her exercise-related control, commitment, and confidence. These psychological factors may in turn help facilitate exercise adherence.

Stevens et al.⁹⁷ obtained social support data from 96 participants (age range = 49 to 79 years) who engaged in an 18-month prospective study designed to promote physical activity in sedentary adults. A stages of change questionnaire determined that these participants were in the precontemplation and contemplation stages of behavior change at the start of the program. This

questionnaire was repeated at six months and 18 months. Participants were classified as nonadherers if they were not in the action or maintenance stages at the end of 18 months and adherers if they were in the action or maintenance stages at the end of 18 months. Their social support for exercise was measured at baseline, six months, and 18 months via the Social Support for Diet and Exercise Behaviors Scale. Adherers perceived significantly more social support from friends at all three time points relative to the nonadherers. Adherers also reported significantly more social support from group members at the latter two time points compared to the nonadherers. Based on a multivariate discriminant analysis, task self-efficacy, social support from group members, and enjoyment of physical activity explained most of the difference between adherers and nonadherers at the end of the study. These findings suggest that social support for exercise, particularly from friends and group members may be influential when it comes to physical activity adherence.

As noted earlier, Bravata et al.⁷ reviewed the literature centered on pedometer use and physical activity, reporting that two self-regulatory strategies (e.g., having a step goal and using a step diary) were two key predictors of increased physical activity. For example, Swartz et al.¹³ conducted a 12-week study in which 18 overweight, inactive women completed an eight-week physical activity intervention. They initially completed a four-week control period, engaging in their usual physical activity habits. Then, they were given a goal of accumulating 10,000 steps/day and asked to wear a pedometer for eight weeks, so they could record their daily steps and exercise in an activity log. Participants significantly increased their steps from baseline by about 4,200 steps/day. This finding suggest that utilizing a combination of self-regulatory strategies (i.e., step goal, pedometer, and activity log for self-monitoring) appears to be a successful physical activity promotion approach for overweight, inactive women.

Hallam et al.⁹⁸ found evidence of a favorable link between self-regulation and exercise behavior among worksite employees. They conducted physical activity intervention, examining two groups. Participants' self-regulation was measured via a questionnaire containing six Likert-type subscales at baseline, 6 weeks, 6 months, and 12 months. The treatment group attended four one-hour sessions across two weeks in which they received educational instruction regarding concepts related to exercise promotion (e.g., dispelling myths, increasing use of self-regulatory skills, identifying expected outcomes, and learning how to engage in an exercise program among others). They had access to an on-site fitness facility. Sixty participants were originally part of the treatment group, but only 40 participants completed the questionnaire at all four time points. The comparison group engaged in an orientation of the fitness facility and instruction on proper use of the exercise equipment. The comparison group was originally comprised of 120 participants, but only 28 participants completed the questionnaire at all four time points. Exercise behavior was measured with a seven-day recall instrument. A significant group-by-time interaction was found for self-regulation. The intervention group experienced a significant increase in self-regulation between baseline and each one of the other three time points relative to the control group. A significant difference between groups in total days of exercise was found at 12 months. The treatment group reported exercising on significantly more days/week at each one of the three time points compared to baseline and also exercised significantly more days/week at 12 months relative to the control group. The authors tested for mediation and found that self-regulation mediated the effect of the intervention on exercise behavior. Targeting self-regulation skills may be an effective way to improve exercise adoption and adherence.

Evidence detailing the link between outcome expectations and physical activity is less consistent than the evidence describing the relationship between the other three aforementioned psychosocial constructs and physical activity.⁸⁰ Williams et al.⁷¹ conducted a review of the literature centered on the application of outcome expectations in physical activity research. They found that some studies of adults have shown small, significant and positive correlations between positive outcome expectations and physical activity. For instance, one study centered on this topic⁹⁹ analyzed data from a mailed questionnaire that was completed by a randomly selected community sample of 2,053 adults. In order to assess their frequency of vigorous exercise, an item asking them to report how often (times/week) they do physical exercise (hard enough to make their heart rate and breathing increase a large amount) in their free time for at least 20 minutes without stopping was used. Additional items within the survey assessed 24 other variables thought to be linked to physical activity, including positive outcome expectations (i.e., expected benefits of exercise). Ten items were used to address the respondents' level of outcome expectations for exercise. A small ($r = 0.24$), but positive and significant correlation was found between reported expected benefits of exercise and vigorous exercise. Respondents who reported a higher level of perceived expected benefits of exercise, engaged in vigorous exercise more frequently than those who possessed a lower level of perceived expected benefits of exercise. However, Williams et al.⁷¹ noted that other studies of adults have not found an association between these two variables.

In addition, some studies of adults have found that outcome expectations predict variance in physical activity beyond that accounted for by self-efficacy, but other studies have not observed this association. For instance, in a study conducted by Conn,¹⁰⁰ 225 community-dwelling older women (≥ 65 years) completed measures of exercise behavior (exercise

component of the Baecke Physical Activity Scale), self-efficacy (six survey items rated on a five-point scale that address respondents' belief in their abilities to exercise), and positive exercise outcome expectations (eight survey items). A significant, positive correlation ($r = 0.38$) was found between exercise outcome expectations and exercise behavior. However, exercise outcome expectations and self-efficacy were positively related ($r = 0.49$), and in the planned regression analysis that included four other variables (income, health, smoking history, and exercise self-efficacy), the exercise outcome expectations variable was not a significant predictor of exercise behavior. Health and exercise self-efficacy were significant predictors of exercise behavior though. The findings suggest that outcome expectations may not explain much variance in exercise behavior in older women beyond that accounted for by self-efficacy. Overall, Williams et al.⁷¹ concluded that additional research on the topic of outcome expectations and physical activity is needed.

Moreover, some studies^{65,66,80,101-103} have used formal mediation analyses in order to explore how the four previously mentioned psychosocial variables work together to impact physical activity. Anderson et al.⁶⁶ analyzed data from 999 adults (66% female and 21% African-American; mean age = 52.73 ± 14.56 years) who were participating in the baseline phase of a health promotion study. Social support for physical activity was measured with three items that asked participants to rate on a 5-point scale their perceived support from family members. Self-efficacy was measured via items from two scales (Self-efficacy for Overcoming Barriers to Increasing Physical Activity and Self-efficacy for Integrating Physical Activity in the Daily Routine). Positive and negative outcome expectations were measured by a total of nine items, which asked participants to rate on a five-point scale if they expected to experience certain benefits and negative consequences, respectively, as a result of increasing their activity level.

Self-regulation was assessed by seven items, which asked participants to rate on a 5-point scale how often they used certain physical activity-related self-regulation strategies. Participants completed physical activity diaries for one week, and the information from their diaries was used to quantify their physical activity in terms of metabolic-hours/week (MET-hr/wk). They also wore a pedometer during the same week and recorded their daily steps. The authors tested the fit of a model that included demographic variables in addition to the psychosocial variables and physical activity (MET-hr/wk and steps/day). The model provided a good fit to the data, explaining 46% of the variance in the participants' physical activity levels. Age, race, social support, self-efficacy, and self-regulatory strategies contributed to the physical activity levels. The total effect of self-regulation on physical activity was positive and greater than the total effect of self-efficacy, but self-efficacy was a key precursor to self-regulation. Social support positively influenced self-regulation directly and indirectly through self-efficacy. Outcome expectations did not influence physical activity beyond self-efficacy. The results indicate that physical activity interventions should aim to enhance self-regulatory behaviors, modeling of family members, and self-efficacy.

In another study,⁶⁵ 661 adults (mean age = 54.02 ± 13.89 years) from randomly assigned churches participated in a seven-month, Internet-based physical activity and nutrition program. One study condition was a wait-list control group. Another study condition had access to an Internet program, and a third study condition had access to both an Internet program and church-based supports (i.e., prompts in church bulletins and posters and a church-wide step drive). The Internet program consisted of 12 weekly SCT-based modules. All participants completed physical activity diaries for 16 months (during the intervention and a follow-up period), and the information from their diaries was used to quantify their physical activity (MET-hr/wk). They

also wore a pedometer for the same 16-month time period and recorded their daily steps, which served as another measure of physical activity. The Health Beliefs Survey was used to measure participants' physical activity-related social support, self-efficacy, outcome expectations, and self-regulation at baseline and the end of the seven-month intervention. The third study condition (Internet plus church support) had a greater increase in daily steps from baseline to the end of the follow-up period compared to the control group. The authors tested the fit of a model that included the intervention treatment (Internet plus church support), all SCT psychosocial variables, and change in physical activity. They specifically evaluated the mediation of treatment effects on physical activity. The fit of the model was good, explaining 18% of the variance in physical activity change. The positive effect of the treatment on physical activity at 16 months was mediated through improvements in self-efficacy and self-regulation at seven months. Change in self-regulation at seven months was found to be a potential mediator of the effect of change in self-efficacy at seven months on physical activity at 16 months. Additionally, the treatment influenced self-efficacy and self-regulation in part by increasing participants' perceived social support. While the treatment increased positive outcome expectations, the improvements just marginally influenced physical activity levels. The findings suggest that physical activity interventions should target self-regulation strategies in part by enhancing exercise self-efficacy. Likewise, social support should be targeted in physical activity interventions given its influence on self-efficacy and self-regulation.

Resnick¹⁰¹ conducted a descriptive study in which 201 older adults (≥ 65 years) were asked to complete measures of exercise self-efficacy (Self-efficacy for Exercise Scale) and outcome expectations for exercise (Outcome Expectations for Exercise Scale). Prior exercise behavior and current exercise behavior were assessed via a survey administered one year prior to

the study and at the time of the study, respectively. The authors tested a model of current exercise behavior that included the two aforementioned psychosocial variables and prior exercise behavior, as well as other relevant variables (e.g., health status; gender; fear of falling). The model provided a reasonable fit for the data, accounting for 40% of the variance in exercise behavior. Enhanced physical health and increased prior exercise were associated with increased self-efficacy, explaining 22% of the variance in this variable. Physical health, mental health, and self-efficacy were positively linked to outcome expectations, explaining 49% of the variance in this construct. Prior exercise behavior, self-efficacy, and outcome expectations were directly and positively associated with current exercise behavior. Of note, outcome expectations had a significant, independent relationship with current exercise behavior. The findings suggest that finding ways to strengthen older adults' self-efficacy and outcome expectations for exercise may help improve their exercise behavior.

Rovniak et al.⁸¹ used a prospective design to test an SCT-based model of physical activity among 277 university students. Participants' self-efficacy (Making Time and Resisting Relapse subscales from the Self-efficacy for Exercise Behaviors Scale), outcome expectations (Benefits of Physical Activity Scale and Physical Activity Enjoyment Scale), social support (Friend Support for Exercise Habits Scale), self-regulation (Exercise Goal-setting Scale and Exercise Planning and Scheduling Scale), and physical activity (Stages of Change for Exercise Behavior Scale and modified version of the Aerobics Center Longitudinal Study Physical Activity Questionnaire) were measured at baseline. They completed the physical activity assessments again after eight weeks. The model accounted for 55% of the variance in observed physical activity. Higher levels of social support for physical activity led to higher levels of exercise self-efficacy, and in turn, physical activity measured at eight weeks. Higher levels of self-efficacy

had the most substantial impact on physical activity primarily through improvements in self-regulation and to a lesser extent, outcome expectations. Self-regulation also had a strong total effect on physical activity. The coefficient related to the effect of outcome expectations on physical activity was high enough to be considered important. The results suggest that physical activity interventions should aim to improve exercise self-efficacy in part by focusing on enhancing social support for physical activity. Improvements in self-efficacy will likely result in improvements in self-regulatory skills, which collectively represent an influential determinant of physical activity behavior.

Resnick et al.¹⁰² interviewed 74 older adults, gathering information about their exercise self-efficacy (Self-Efficacy for Exercise Scale), exercise outcome expectations (Outcome Expectations for Exercise Scale), social support for exercise (Social Support for Exercise Scale), and exercise behavior. The participants were asked to state whether or not they participated in at least 20 minutes of regular aerobic or resistive exercise three times per week (yes or no). The authors aimed to test a model of exercise behavior that included these variables, as well as age. The model fit the data, explaining 53% of the variance in exercise behavior. Friend support indirectly influenced exercise through self-efficacy. Self-efficacy influenced exercise behavior directly and indirectly through outcome expectations. Outcome expectations directly influenced exercise behavior. The authors concluded that social support from friends seems to have a stronger influence on older adults' exercise behavior than social support from family or experts. In addition, both self-efficacy and outcome expectations independently influenced exercise behavior. Thus, all three psychosocial constructs should be considered when designing physical activity interventions.

Anderson-Bill et al.¹⁰³ sought to evaluate the social cognitive determinants of physical activity among 963 adults (mean age = 44.4 ± 11.03 years) enrolling in an Internet- and SCT-based nutrition, physical activity, and weight management program. Participants wore a pedometer and recorded both their daily steps and daily minutes walked in a seven-day walking log. They also completed the Health Beliefs Survey online, which allowed for an assessment of physical activity-related social support, self-efficacy, self-regulation, and outcome expectations. The authors' SCT model provided a good fit to the participants' data, explaining 22% of the variance in measured levels of physical activity. Social support for physical activity from friends and family provided a considerable contribution to participants' physical activity levels, partially indirectly through self-regulation. Participants who possessed a higher level of perceived social support were more likely to use self-regulatory strategies. Participants with higher levels of exercise self-efficacy were more active, and this effect was largely direct; however, self-efficacy was also a predictor of self-regulation and outcome expectations. Participants who had a higher self-efficacy were more likely to engage in self-regulatory behavior and expect to experience the benefits of being active. Self-regulation was a strong predictor of participants' physical activity. The results indicate that SCT-based physical interventions in which social support from significant others is a central feature may be an effective way to improve self-regulation, and in turn, physical activity. Success of such interventions may also depend on the extent to which they enhance participants' exercise self-efficacy.

Internet- and Smartphone application-based Physical Activity Interventions

The Internet and smartphone applications are two attractive delivery methods for physical activity interventions. Easy access, convenience/flexibility of use, innovativeness, efficient real-time and asynchronous communication, a high degree of anonymity if desired, and the ability to

easily distribute materials and reach a large number of people are advantages of using such technologies to administer a behavior change intervention.¹⁰⁴⁻¹⁰⁶ Findings from reviews of literature focused on Internet-based physical activity promotion studies point to the promise of this technology as a delivery medium for the promotion of physical activity among different populations.¹⁰⁷⁻¹⁰⁹ These reviews of literature also note that most of these studies have been grounded in a behavior change theory, including the SCT.¹¹⁰⁻¹¹⁶ For example, Cook et al.¹¹⁰ randomly assigned 419 employees of a human resources company to a health promotion Internet-based program (n = 209) condition or a health promotion print condition (n = 210), each lasting three months. The Internet-based program offered information and guidance on a number of health topics, including physical activity. It was partially rooted in the SCT and designed to improve health practices, knowledge, and attitudes. It was highly interactive, characterized by numerous graphics, audio, and video. The print group received the same information in colorful booklets. All participants completed online survey assessments of frequency of physical activity (Godin Leisure-Time Exercise Questionnaire), frequency of engaging in strenuous physical activity (Godin Sweat Score), exercise stage of change (single question), and exercise self-efficacy (single question) at baseline and post-intervention. Both groups significantly improved their Godin Sweat Score and exercise stage of change, but there were no differences between groups on these measures. The print group significantly improved their exercise self-efficacy, but the Internet-based group's exercise self-efficacy did not change (although there was a borderline significant increase). While each group's self-reported frequency of physical activity increased, this increase was not significant. The reported frequency with which participants accessed the physical activity parts of the Web-based program was low overall. Interestingly, the Internet group gave significantly higher ratings to the program materials than the print group

on all health topics on a post-intervention online evaluation of the program. Based on these results, it seems as if the SCT-based Internet program and the SCT-based print program were equally as effective at facilitating increased engagement in strenuous physical activity, stage of change in adhering to physical activity, and possibly exercise self-efficacy among employees. The authors suggested that finding ways to increase the frequency of access to the Internet program might improve its efficacy. The Internet group's higher ratings of the program indicated that Internet-based materials are preferable to print-based materials.

Napolitano et al.¹¹¹ randomized 65 healthy, insufficiently active adults to either an Internet-based group (n = 30) or a waitlist control group (n = 35). The Internet-based group received access to an SCT-based website for three months that contained research-based physical activity information. They also received weekly SCT-based tip sheets by e-mail. Participants were instructed to engage in moderate-intensity activity on at least five days per week. Both groups completed the Physical Activity Stage of Change measures, as well as the Behavioral Risk Factor Surveillance System physical activity items at baseline, one month, and three months. Fifty-seven participants (24 intervention and 33 control) were retained at one month. The Internet-based group was significantly more likely to have move forward in terms of motivational readiness and also engaged in significantly higher amount of moderate-intensity activity, as well as walking, compared to the control group. Fifty-two participants (21 intervention and 31 control) were retained at 3 months. Compared to baseline, the Internet-based group's stage of motivational readiness was significantly more likely to progress relative to the control group. The Internet-based group also still engaged in a significantly higher amount of walking minutes at three months compared to the control group. These findings indicate that the combination of an SCT-based website, physical activity goal, and weekly e-mail tips may

effectively promote improvements in terms of both motivation to be active and actual physical activity in the short-term for sedentary, healthy adults.

Plotnikoff et al.¹¹² administered a 12-week physical activity intervention, randomly assigning employees to an intervention group (n = 1,566) or a waitlist control group (n = 555). The intervention group received weekly e-mail messages focused on physical activity and nutrition. The messages were based on behavior change theories, including the SCT. Self-efficacy was measured at baseline and post-intervention using a validated eight-item scale. Physical activity was measured at the same time points via the Godin Leisure Time Exercise Questionnaire and reported as total energy expenditure (MET minutes). The intervention group significantly increased their total MET minutes of physical activity from baseline; whereas, the control group's total MET minutes of physical activity decreased from baseline. The intervention group reported significantly enhanced self-efficacy from baseline; whereas, the control group reported decreased self-efficacy. Based on these results, theory-based, physical activity promotion e-mails represent a promising way to enhance self-efficacy and physical activity among adults in workplace settings.

Another 12-week, SCT- and e-mail based study¹¹³ aimed to promote physical activity among a sample of sedentary, adult women. Sixty-one women were randomized to a high fidelity program (n = 30) or a low fidelity program (n = 31). Both groups attended an orientation session in which they received information about the benefits of walking, as well as a walking log. They were asked to walk three times per week for 30 minutes each time and self-monitor their walking. Participants were asked to return weekly walking logs by e-mail. They received feedback via e-mail after each submission. However, the high fidelity group also received more specific short-term and long-term goals, feedback, and a modeling demonstration. Self-

reported walking quantity (average minutes walked per week in the last two weeks) was assessed at baseline, post-intervention, and one-year follow-up via two items from the National Health Interview Survey; whereas, SCT constructs (self-efficacy, outcome expectations, self-regulation, and social support) were measured only at baseline and post-intervention via questionnaires (Self-efficacy for Exercise Behavior Scale, Benefits of Physical Activity Scale, Exercise Goal Setting and Planning Scales, and Social Support for Exercise Scale, respectively). The 1-mile walk test was also administered at baseline and post-intervention, allowing for a measure of walking speed. Twenty-five women in each group completed the study. Goal setting and positive outcome expectations for walking significantly increased for the high fidelity group to a greater extent than the low fidelity group. Walking self-efficacy and family and friend social support did not change for either group. Self-reported walking quantity increased from baseline (average of 17.45 minutes) to the one-year follow-up (average of 51.68 minutes) for the high fidelity group, and this increase was more than twice as large as the increase observed for the low fidelity group during this same time period; however, the difference was not statistically significant. Compared to the low fidelity group, the high fidelity group walked faster at post-intervention. The findings indicate that implementing theory-based recommendations with greater precision may bolster the effectiveness of physical activity interventions.

Three studies^{86,114,115} used course-based Internet technology to deliver physical activity interventions. Using established, dynamic platforms to deliver a physical activity intervention is advantageous as there is no need to rely on specialized skills or expertise to build an interactive website. Grim et al.¹¹⁴ carried out a three-group, quasi-experimental study. They compared the effect of three different university courses on college students' physical activity. One group (n = 143) of students was enrolled in a course delivered through course-based Internet technology.

They completed SCT-based lessons and a weekly online physical activity log. Another group (n = 93) participated in a traditional, in-person physical activity promotion course. A third group (n = 86) completed a traditional, in-person general health course. A seven-day physical activity recall of days of both moderate and vigorous physical activity was administered at baseline and post-intervention. Self-regulation, self-efficacy, social support, and outcome expectations were also measured at baseline and post-intervention via questionnaires. The authors found a significant increase in reported vigorous days of physical activity and self-regulation among the Internet-based and traditional physical activity groups relative to the health group. All groups' friend social support and outcome expectations for physical activity scores increased across time. The findings suggest that a course-based Internet technology physical activity intervention was equally as effective as an in-person intervention in facilitating vigorous physical activity and improving three SCT-constructs in college students.

Magoc et al.⁸⁶ conducted a randomized controlled trial and observed less favorable outcomes in terms of changes in psychosocial variables. They assigned 117 insufficiently active, predominantly Hispanic college students to an intervention group and a control group. An online course management platform called WebCTTM was used as the physical activity promotion medium for both groups. The intervention group engaged in a six-week program in which they completed seven SCT-based lessons. The control group had access to basic tip sheets about physical activity. Both groups also submitted weekly physical activity logs if they desired. Participants completed measures of self-reported physical activity (International Physical Activity Questionnaire or IPAQ), self-regulation (EGS and EPS), social support (Family and Friend Support for Exercise Habits scales), self-efficacy (Self-efficacy for Exercise Behavior scale), and outcome expectations (Outcome expectations and expectancies scale) at baseline and

the end of the study. Thirteen participants dropped out of the study (4 control and 9 intervention). The intervention group showed significant increases in both the number of moderate days and vigorous days of physical activity, but the control group experienced no change in these variables. There were no significant changes in any of the psychosocial variables as a function of condition. The findings indicate that an SCT-based, online intervention delivered through a course management platform can increase self-reported physical activity in college students compared to a non-theory based condition; however, the intervention failed to influence potential mediators of behavior change based on the psychosocial measures.

Ornes et al.¹¹⁵ also used WebCT to deliver a four-week walking intervention. A sample of 112 college-aged women were randomly assigned to one of three groups after a one-week, pedometer-based, baseline assessment of physical activity. The intervention group (n = 53) wore a pedometer (Yamax, SW 200) and gained access to a course-based Internet website. Nine SCT-based modules were accessible via the website. One of the modules encouraged them to set a personalized goal (gradually progress from 1,000 steps/day above baseline to 3,000 steps/day above baseline) and monitor their progress. Participants obtained feedback when they submitted a recording sheet each week via e-mail and incentives were provided to encourage submissions. Another group (n = 30) wore an unsealed pedometer and recorded steps taken, but did not receive an intervention. A third group (n = 29) wore a sealed pedometer, but did not receive an intervention. They met with a researcher each week, so their steps could be recorded. For the evaluation of differences between groups in terms of daily steps, the two control groups were collapsed into one group since their steps/day were generally similar across each week of the study. The intervention group increased their steps/day each week of the study, and achieved a significantly higher number of steps/day during each week compared to the controls. While the

step count data was only displayed in a figure, it appears that the intervention group increased their steps/day by an average of at least 3,000 from baseline to the end of the study. The findings point to the effectiveness of a WebCT-mediated and SCT- and pedometer-based intervention for promoting walking in college-aged women.

Mailey et al.¹¹⁶ also used a pedometer as part of an SCT-based, Internet-mediated intervention. They conducted a 10-week physical activity intervention, randomly assigning college students who were receiving mental health counseling to one of two groups. The intervention group ($n = 24$) was asked to wear a pedometer (Omron HJ720-ITC) and provided with software to download the data to their personal computer. This information was sent to the researchers at the end of each month. Participants were also asked to submit activity logs electronically at the end of each week. They were given access to a website that contained four SCT-based modules and attended two monthly meetings with a physical activity counselor. The counselor provided feedback, helped participants set goals, and discussed outcome expectations and overcoming barriers. The second group was a waitlist control group ($n = 23$). Physical activity was measured using an accelerometer, which participants wore for one week prior to the start of the study (baseline measure) and one week at the end of the study. Self-efficacy was assessed via both the Exercise Self-Efficacy scale and the Barriers Self-efficacy scale at baseline and post-intervention. Four students dropped out during the duration of the study (three intervention and one control). The intervention group experienced a significantly greater increase in accelerometer-measured physical activity than the control group. Both groups experienced a significant decline in both barriers self-efficacy and exercise self-efficacy. Changes in physical activity were significantly and positively associated with changes exercise self-efficacy ($r = 0.62$) and barriers self-efficacy ($r = 0.63$) in the intervention group, but not in

the control group. The authors put forth the notion that the decline in self-efficacy may have partially been attributed to participants recalibrating their expectations based upon information and experiences they gained from participation. However, both the improvements in physical activity and the observed associations between physical activity changes and self-efficacy changes in the intervention group suggest that the SCT framework may have had its intended effect. Overall, an Internet-based program appears to be a promising way to facilitate improvements in physical activity among students with mental health issues.

Watson et al.¹¹⁷ asked participants in their 12-week study to wear a pedometer (ActiPed) and access a corresponding website to view step counts. The pedometer wirelessly transmitted activity data to a USB receiver on the participants' personal computer, allowing them to view their progress and set goals on the ActiHealth website. Participants were randomly assigned 70 overweight and obese adults to either an intervention arm ($n = 35$) or a control arm ($n = 35$). In addition to the pedometer and corresponding website, intervention participants also were provided access to a virtual coach, which consisted of a computer-animated exercise advisor that ran via software installed on the participants' computers. The virtual coach was able to provide tailored interactions and advice based on the SCT. Participants were instructed to interact with the coach three times per week for five to ten minutes. The percentage change in step count was the primary outcome. In order to examine this change, the study period was divided into four, three-week time periods (P1, P2, P3, and P4). Participants' self-reported physical activity, physical activity stage of change, exercise benefits, and self-efficacy were measured via a survey at baseline and post-intervention. Eight participants dropped out of the study (four from each group). The average step count significantly decreased in the control group from P1 to P4 (7174 to 6149), but it did not change in the intervention group (6943 to 7024). The percentage change

in mean activity levels between the two groups from P1 to P4 was not statistically significant. A significant difference in this variable between the two groups was observed when comparing it over all time points. No significant changes were observed in any other measured outcomes. The findings suggest that a virtual coach may be an effective, adjunct to more established physical activity intervention components (i.e., pedometer and website) when it comes to promoting sustained physical activity in overweight and obese adults.

Richardson et al.¹¹⁸ carried out a six-week intervention in which participants received access to an automated Internet-based program involving the use of a pedometer (Omron HJ720-ITC) that also allowed participants to directly upload their steps to a website. Thirty-five type 2 diabetic, sedentary adults were randomized to a lifestyle goals group (LG) (n = 19) or a structured goals group (SG) (n = 16). Participants in both groups completed a one-week, pedometer-based, baseline assessment. Then, they gained access to a personalized webpage characterized by motivational messages, tips about diabetes management, automatically calculated goals, and feedback about progress. They were asked to upload their steps from their pedometer to their personal webpage using a USB cable on a weekly basis or more frequently if desired. The LG group was told to focus on total accumulated steps (averaging the previous seven days of total step data and adding 1,200 steps to the average). The SG group was told to focus on bout steps (walking that lasts for at least 10 minutes at a pace of 60 steps/minute). Their goals were calculated by averaging the previous seven days of bout steps and adding 800 steps to the average. Five participants dropped out of the study (two LG group and three SG group). Both groups significantly increased their mean daily bout steps between baseline and the end of the study, but there was no difference between groups. Three-fourths of the LG group successfully increased their total steps by increasing their bout steps. There was no difference

between groups in the increase in total steps. When the two groups were collapsed, participants increased their daily bout steps by an average of 1,921. LG participants were more satisfied with the program than the SG participants based on a post-intervention online survey. Such results suggest that an Internet-mediated, pedometer-based program involving a step goal can effectively increase bout walking regardless of whether the goal centers on total steps or bout steps. A total step goal may be result in more satisfied participants, which could have implications for walking adherence.

Only a small number of smartphone application-based studies¹¹⁹⁻¹²¹ have reported physical activity behavior change results, and two of these studies used both a combined website and smartphone application approach.^{119,120} Two^{120,121} of these three studies are described in the next section (“Online Communities and Physical Activity Promotion) since they incorporated an online community as part of their intervention. Kirwan et al.¹¹⁹ conducted a two-arm, matched case-control study, recruiting adults who were already participating in an Internet-based 10,000 steps program. Fifty intervention participants were matched to a control group (n = 150) who were similar in age, gender, membership length, and average number and frequency of steps logged for the three months prior to the intervention. Participants in both groups were wearing a pedometer and could still log and track their steps on a website during the three-month study, but the intervention group could also use a smartphone application to log and track their steps. A significant decline in the frequency with which participants in the matched group logged their steps was observed over the study period (mean of 61 days at baseline to 41 days at the end of the study) compared to the intervention group, which maintained their logging frequency (61 days at baseline and 62 days at the end of the study). Both groups averaged approximately 10,000 steps per day at baseline. The intervention group maintained their daily step count (mean

= 11,100 steps per day) throughout the three-month intervention, but the control group's step count significantly declined to 6,200 steps per day. The intervention group used the smartphone application 71% of the time to log their steps. The use of the smartphone application was associated with an increased likelihood to log steps each day compared to participants who were not using the application. The findings indicate that using a smartphone application as a complementary delivery tool to a website, can encourage active adults to self-monitor and maintain their physical activity behavior.

It is clear that there is a paucity of physical activity behavior change research involving smartphone applications. Additionally, Internet-mediated, SCT-based physical activity interventions have generally demonstrated promise for influencing physical activity among different populations. Yet, most of these studies relied on self-reported measures of physical activity, and mixed results were found in terms of changes in presumed mediators of physical activity behavior change. Based on the aforementioned reviews of literature in this area,^{107,108} many other Internet-based studies have also used self-reported measures of physical activity. It is also difficult to determine the isolated impact of presumed mediators and specific intervention features on physical activity in these studies due to design limitations.

Online Communities and Physical Activity Promotion

An online community is one intervention feature that has been incorporated into several physical activity promotion studies;^{120,121,123-130} however, the potential, isolated impact of an online community on physical activity behavior is a field of research that is still in its infancy.¹²² Motl et al.¹²³ conducted a randomized controlled trial, examining the effect of a 12-week SCT- and Internet-based program on physical activity among adults with multiple sclerosis. Fifty-four individuals were randomized to the intervention group (n = 27) or a waitlist control group (n =

27). Participants in the intervention group were asked to wear an Omron HJ720-ITC pedometer and had access to a website that contained four SCT-based modules. They also could participate in chat sessions two times each week that were administered by the researchers and engage in a discussion board. Physical activity (MET minutes/week) was assessed at baseline and post-intervention via the Godin Leisure-Time Exercise Questionnaire. Self-efficacy outcome expectations, and goal setting were assessed at the same two time points via the Exercise Self-Efficacy Scale, the Multidimensional Outcome Expectations for Exercise Scale, and the Exercise Goal Setting Scale, respectively. Six participants dropped out of the study (four intervention and two control). The intervention group reported a significantly greater increase in physical activity (increase of 10.9 MET minutes/week) compared to the control group (increase of 0.7 MET minutes/week). The intervention group also reported a significantly greater increase in goal setting relative to the control group. The change in goal setting was significantly and positively associated with the change in physical activity in the intervention group ($r = 0.75$) and mediation analysis showed that goal setting mediated the effect of the intervention on physical activity behavior. No other significant changes were observed among the SCT constructs. The findings indicate that an Internet-based intervention rooted in the SCT can favorably impact physical activity levels and goal setting in persons with multiple sclerosis. The findings also suggest that goal setting is a key predictor of physical activity behavior change.

Liebreich et al.¹²⁴ conducted a 12-week study, randomly assigning 49 adults with type 2 diabetes to an intervention group ($n = 25$) or a control group ($n = 24$). Participants in the intervention group had access to an SCT-based website, which contained educational information, as well as interactive features (physical activity log, message board, and e-mail counseling with the study coordinator). The control group had access to a website that contained

standard care information. Outcome measures were completed online at baseline and post-intervention. Physical activity was assessed using the Godin Leisure-Time Exercise Questionnaire. Responses to this questionnaire were converted to both MET minutes/week and unweighted minutes/week of moderate and vigorous physical activity. Self-efficacy was assessed via a 12-item scale. Outcome expectations were measured using a 17-item scale. Self-regulation was measured via a subscale from the Behavior Regulation in Exercise Questionnaire. Social support was assessed via two items. The intervention group engaged in a borderline significantly greater amount of unweighted moderate and vigorous minutes of physical activity than the control group (mean difference of 47 minutes). No significant interactions were detected for any of the measured psychosocial variables. The findings suggest that an interactive, SCT-based website is an efficacious way to promote moderate-to-vigorous physical activity among adults with type 2 diabetes, but its ability to impact psychosocial variables seemed to be limited. The authors noted that the lack of change in these variables may have been partially attributed to the response shift theory concept (i.e., as an individual's behavior changes, they encounter new situations and barriers, and thus, a shift in their cognitions may occur).

McKay et al.¹²⁵ also reported similar findings. They carried out a short-term (eight week), Internet-based physical activity intervention targeting adults with type 2 diabetes. They randomly assigned 78 participants to an intervention group (n = 38) and an information-only control group (n = 40). The intervention group was given access to a website that led them through a personalized, physical activity program. They were given guidance in terms of selecting a physical activity goal, identifying the benefits of physical activity, and making plans to meet their goal. They also had access to an online physical activity log and support area

(messages from a personal coach and a message board where they could communicate with their peers). The control group had access to a website that allowed them to view relevant articles and track their blood glucose. Physical activity was measured online at baseline and the end of the study via 11 items from the Behavioral Risk Factor Surveillance System. Sixty-eight participants completed the study (35 intervention and 33 control). Both groups significantly increased their self-reported walking and moderate-to-vigorous intensity physical activity, but there were no differences between groups. The intervention group posted 42 messages to the peer support area and logged in to the website a total of 341 times (average of 1.1 per participant per week) based on objective tracking data. A significant, positive relationship was found between log-ins and postings to the peer support group ($r = 0.91$). They also found that those in the intervention group who logged-in to the website more regularly experienced significantly greater improvements in physical activity compared to those who logged-in to the website less frequently. These results suggest that an interactive, Internet-mediated program can facilitate improvements in moderate-to-vigorous physical activity among adults with type 2 diabetes. Finding ways to maximize website engagement (possibly via an online support group) is an area worthy of exploration given its favorable relationship with physical activity behavior.

Another study¹²⁶ focused on female college students, randomizing 91 participants to an intervention group ($n = 45$) or a control group ($n = 46$). The intervention lasted six months, and all participants attended an orientation session in which they were given information about exercise (recommendations, safety, and campus physical activity opportunities), as well as encouraged to engage in a moderate exercise program. Participants in the intervention group also received access to a website consisting of SCT-based information and a discussion board. They also could communicate via e-mail with an exercise physiologist. An online questionnaire

measuring self-regulation, outcome expectations, and self-efficacy was administered at baseline, six weeks, and six months. The short version of the International Physical Activity Questionnaire was also administered online at these three time points. Seventy-nine participants completed the six-week questionnaire (39 intervention and 40 control), and 71 completed the six-month questionnaire (28 intervention and 31 control). The intervention group reported a significantly greater increase in the number of days of moderate-intensity physical activity from baseline to six weeks relative to the control group, and this effect was mediated by self-regulation. No other significant findings were observed. Even though over 60% of the intervention group accessed the discussion board, less than 5% posted a message. The findings suggest that this SCT-based intervention can facilitate more frequent engagement in moderate-intensity physical activity by impacting improvements in self-regulation among college-aged females in the short-term. The authors noted that less than half of the intervention participants reported using a form of social support six weeks into the study as assessed by the self-regulation instrument. The lack of social support developed by the intervention may partially explain the lack of change in self-efficacy and outcome expectations as all three constructs are interrelated.

A three-armed, eight-week, quasi-experimental study was carried out by Huang et al.¹²⁷ They divided 146, first-year, female college students who were attending a nursing class into an experimental group (n = 45), a generic group (n = 42), and a control group (n = 43). The experimental and generic groups had access to physical activity promotion materials via a website that utilized a virtual house comprised of graphics, pictures, and games. The experimental group's materials were matched for their behavior stage of change. They also had access to a chat room. The generic group's materials were non-stage-matched. The control group only received a lecture. Questionnaires were administered at baseline, post-intervention,

and five-months follow-up to measure exercise stage of change, physical activity (METs), and exercise self-efficacy. The participants in the experimental group experienced the most improvement in terms of change in stage of exercise from baseline to two months, two months to five months, and baseline to five months. Self-reported physical activity was significantly higher at the end of the study compared to baseline, as well as at five months compared to the end of the study for both the experimental and generic groups; whereas, self-reported physical activity significantly decreased from baseline to the end of the study for the control group. The intervention group reported a greater increase in self-efficacy from baseline to the end of the study relative to the other two groups. A stage-matched, interactive website appears to be an efficacious way to promote physical activity and exercise self-efficacy among female college-aged students.

Valle et al.¹²⁸ randomly assigned young adult cancer survivors to one of two groups for a 12-week study. All participants wore a pedometer (Digi-Walker SW-200) and received a physical activity goal (increase moderate-intensity physical activity to at least 150 minutes/week). Participants in both groups had access to their respective Facebook group. All participants received a weekly Facebook message from the researchers via the private message function. These messages focused on physical activity information. One group (Self-help; n = 41) had access to all the Facebook group features (post comments, share links, share videos), but the study administrator did not participate in the group, so all interaction was self-directed. The other group (fostering improvement through networking and exercise together or FITNET; n = 45) also had access to all the Facebook group features, and the study administrator posted prompts to encourage interaction. This group's weekly private messages were more substantive and based on the SCT. Participants in the FITNET group also had access to a separate website

that contained a goal-setting tool, physical activity diary, feedback charts, and relevant tips. All participants self-reported physical activity (Godin Leisure Time Exercise Questionnaire) at baseline and the end of the twelve weeks. Sixteen participants were lost to follow-up (10 FITNET and 6 Self-help). Both groups significantly increased their reported weekly minutes of moderate-to-vigorous physical activity (mean increase of 67 and 46 minutes for the FITNET and Self-help group, respectively), but there was no difference between groups. The FITNET group had a significantly greater reported increase in light physical activity compared to the Self-help group (mean difference of 135 minutes/week). FITNET participants posted 153 comments; whereas, Self-care participants posted 188 comments. Nearly half of the participants in both groups made two or more Facebook posts. The number of posts was not related to self-reported physical activity in either group. These results suggest that pedometer-based, Facebook-mediated approaches may be effective ways to promote physical activity among young adult cancer survivors.

Cavallo et al.¹²⁹ also examined the efficacy of a 12-week, Facebook-mediated approach for promoting physical activity. They randomized female undergraduate students to a Facebook group (n = 67) or an education-only control group (n = 67). The Facebook group had access to a website that provided educational information, a self-monitoring tool, a goal setting tool, and feedback charts. They could also join a Facebook group and were incentivized to make posts on the group wall or Facebook discussion board (entered into a biweekly gift-card drawing based on contributions to the group). The study coordinator encouraged participation, but did not provide support. The control group received access to a limited version of the website described above. Perceived social support was measured at baseline and 12 weeks via an online survey. All participants completed the Paffenbarger activity questionnaire at baseline and the end of the

study. A post-intervention questionnaire measured participants' unobservable behavior in the Facebook group. Thirty-seven intervention participants made more than one post, 32% of the 259 participant interactions were on the discussion board, and 50% were on the group wall. Over half of the intervention participants who completed the post-intervention questionnaire reported visiting the Facebook group at least two to three times each month. Both groups significantly increased their perceived social support and physical activity, but there were no differences between groups. The authors concluded that the combination of a Facebook group and other supportive tools did not produce enhanced social support and physical activity beyond that elicited by an Internet-based, education-only group among female students. Yet, given the reach and dynamic features of online social networks, the authors suggested that further exploring their use in terms of health behavior change is warranted.

Hurling et al.¹³⁰ carried out a nine-week randomized controlled trial that was characterized by an Internet- and mobile phone-based physical activity intervention. All participants were healthy adults and wore a Bluetooth wrist-worn accelerometer, so their physical activity could be monitored at baseline for three weeks and continuously for the duration of the intervention period. They also completed the long version of the IPAQ (MET minutes/week) at baseline and post-intervention. The intervention participants (n = 47) were given access to an interactive website that helped them identify barriers and solutions and asked them to report their exercise level during the past week. They received feedback about their performance from the website program and e-mail or mobile phone reminders about planned physical activity sessions. They also had access to a message board and could track their physical activity, which was automatically relayed to the website from the accelerometer. Optional, motivational e-mails or mobile phone text messages were also sent to the participants.

The control group (n = 30) only received verbal advice on recommended physical activity levels. The message board was one of the most frequently used features of the website. Based on an intent-to-treat analysis, the intervention group reported a significantly higher level of leisure time physical activity compared to the control group. Based on the accelerometer data, a significant trend was found over the whole study period for activity time spent in the three to six MET range for the intervention group versus the control group (an average difference of 19.7 minutes/day). The findings suggest that a combined Internet and mobile-phone based intervention can facilitate an increase in reported and objectively-measured physical activity in healthy adults.

In another study centered on physical activity and diet,¹²⁰ overweight and obese adults were randomly assigned to a podcast only group (n = 49) or a podcast plus mobile media group (n = 47). Both groups received two SCT-based podcasts per week for six months via a website, which could be accessed via a computer or smartphone. The podcast plus mobile group also downloaded a diet and physical activity monitoring smartphone application, as well as Twitter's™ smartphone application (a social networking site). They were encouraged to post at least daily to Twitter. Twitter cohorts of 11 to 12 participants were formed during the first three months, and everyone in this group could view each other's posts from months three through six. The study coordinator posted two messages per day to facilitate communication. Participants completed the Paffenbarger Physical Activity Questionnaire online at baseline, three months, and post-intervention. Their social support was assessed at 6 months via online questions, and the podcast plus mobile participants also answered weekly questionnaires about their Twitter use. Eighty-seven of the participants (45 podcast and 42 podcast plus mobile) completed the three-month assessment, and 86 completed the six-month assessment (44 podcast and 42 podcast plus mobile). There was no significant group-by-time interaction for reported physical activity, but

both groups experienced an increase in reported activity from baseline to three months and baseline to six months. Most (94%) of the podcast plus mobile participants made at least one post to Twitter and on average, participants in this group made 2.1 posts per week.

More of the podcast plus mobile participants reported relying on online sources for their main form of social support during the intervention; whereas, more of the podcast participants reported relying on friends as their main form of social support. There was no difference between groups in terms of their perceived social support. The authors noted that in general, the monitoring smartphone application and Twitter were overall poorly used by the participants. The findings suggest that the combination of podcasts, a self-monitoring smartphone application and support via Twitter was not any more effective for stimulating improvements in physical activity than the use of podcasts alone for overweight and obese individuals. The authors noted that the podcast plus mobile group's use of Twitter may have displaced support from real-life family and friends as opposed to providing an additional form of support. Although weight loss is not a primary focus of this literature review, it is worth mentioning that Twitter use was favorably associated with weight loss, suggesting that the social network may have been particularly beneficial for some users in terms of behavior change.¹³¹

One recent study¹²¹ incorporated a discussion board into a smartphone application. King et al.¹²¹ developed three different smartphone applications, which were based on behavioral science theory and evidence. An iterative design process was used to develop the applications and confirm their theoretical fidelity. One application (analytic) focused on goal setting, self-monitoring, and problem solving. A second application (social) focused on social comparisons, norms, and support. An electronic message board was available as part of this application. It allowed participants to post messages to their peers who were also using the application. A third

application (affective) was based on the principles of reinforcement scheduling and emotional transference. Sixty-eight adults who were not familiar with smartphones were randomly assigned to utilize one of the analytic ($n = 22$), social ($n = 23$), and affect ($n = 23$) applications for eight weeks. All participants also had access to an accelerometer-based smartphone application that facilitated self-monitoring of physical activity. A subgroup of participants was permitted to use their respective application after the eight-week intervention, allowing the investigators to gauge how long participants would continue to interact with this feature. The CHAMPS Physical Activity Questionnaire was used to assess physical activity at baseline and the end of the study. Significant mean increases in reported weekly minutes of brisk walking were found for all three groups (mean increases of 71.1, 122.0, and 105.7 minutes/week for the analytic, social, and affect groups, respectively, but there were no differences between groups), and significant mean increases in reported moderate-to-vigorous physical activity were also found for all three groups (mean increases of 172.9, 257.1, and 134.3 minutes/week for the analytic, social, and affect groups, respectively, but there were no differences between groups). Most participants reported a high level of satisfaction with the applications. The small group of participants ($n = 12$) who continued using the applications did so for an average of 190 out of 233 days (on average, analytic = 211 days; social = 199 days; affect = 162 days). The authors concluded that the applications were acceptable, and integrating behavioral science theory can enhance the impact of mobile phone applications for increasing physical activity in adults.

Unlike the previously mentioned studies, Richardson et al.¹³² actually isolated the impact of an online community on physical activity. They evaluated the effect of two Internet- and SCT-based walking interventions (one with an online community group and one without an online community group) on step counts over 16 weeks. Their sample was comprised of

sedentary adults who were overweight, had type 2 diabetes, and/or coronary artery disease. Participants wore a pedometer for one week prior to the commencement of the study, so their daily baseline step count could be determined. Seventy participants were randomized to the no online community group and 254 participants were randomized to the online community group. Both groups received the same enhanced pedometers, access to a website where they could upload their steps directly from their pedometer via a USB cable and view their progress, individually-prescribed goals, and motivational messages. The online community group also had access to a message board where they could communicate with fellow participants and the researchers. The primary outcome was change in average daily step counts (average end-of-study step counts were subtracted from average baseline step counts). Perceived social support was measured at baseline and post-intervention via a single, unvalidated question. Seventy-seven participants dropped out of the study (53 intervention and 24 control). Out of the 254 participants who were randomized to the online community group, 45% drafted at least one online community post.¹³³ On average, there were 5 posts per person and a median of 2 posts per person over the course of the study.¹³³ In addition, 20% of the 254 participants never made a post, but viewed an average of at least one online community forum page per week.¹³³ Only 5% (12/254) never viewed a forum page.¹³³ While both groups significantly increased their average daily steps between baseline and the end of the 16-week intervention (approximately 2,000 steps/day for the entire sample), there were no significant differences in change in average daily steps between the groups across the intervention period.¹³² Likewise, there was no significant difference in baseline and post-intervention perceived social support between the two groups. However, the online community group uploaded valid pedometer data on more days than the no online community group and had a higher percentage of completers. Among participants who

dropped out of the study, those in the no online community group dropped out earlier than those in the online community group. Plus, a significant, positive relationship was observed between the number of posts to the online community forum and step counts (additional 62 steps/day for each message posted), as well as the number of pages viewed and step counts. The findings indicate that an online community may be an integral component for reducing attrition and stimulating engagement in Internet-based behavior change interventions. The finding concerning social support must be interpreted with caution due to the use of an unvalidated measure. The positive relationships between online community use (posts and views) and step counts suggests that online communities may also be influential in terms of directly promoting physical activity.¹³² Finding ways to maximize the use of them poses a challenge and is worthy of future exploration. Additionally, a need exists to conduct additional randomized controlled trials in which the impact of online communities on physical activity and presumed mediators of physical activity behavior change can be delineated.

Summary Statement

Various technologies with attractive features (e.g., validated Omron HJ-720ITC pedometer, Internet technology, smartphone applications) are available for use in physical activity promotion efforts. Determining how to best utilize these tools to facilitate improvements in physical activity among adults is an active area of research.

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Part III

**UT Moves: Use of Blackboard Learn™ Internet-technology to promote walking among
university faculty and staff**

Abstract

One-third of United States adults are inactive, and the adverse consequences of physical inactivity among Americans are significant. The Internet represents a promising medium for the delivery of physical activity interventions focused on different settings, including the worksite. Using course-related Internet technology (e.g., Blackboard Learn™) is a particularly attractive medium as it does not require special, computer-specific expertise. **PURPOSE:** The efficacy of a Blackboard Learn Internet-technology intervention grounded in social cognitive theory (SCT) for increasing pedometer-measured step counts was examined in a sample of university faculty and staff. **METHODS:** Thirty-six sedentary/insufficiently active faculty and staff members (30 women and 6 men, 48.8 ± 10.1 y) participated in an eight-week, Internet-delivered walking intervention. Participants received an Omron HJ-720ITC pedometer, individualized step goals, and access to a Blackboard Learn webpage comprised of SCT-based components. Participants reported daily steps online, and their social support, self-regulation, self-efficacy, and outcome expectations were measured via validated questionnaires at baseline and post-intervention. Average daily step counts across weeks were compared using repeated measures ANOVA. Paired *t* tests were used to compare other variables of interest. **RESULTS:** Participants significantly increased their average daily steps during the intervention ($p < 0.001$). An increase of 1803 ± 240 steps/day ($p < 0.001$) was observed from baseline (5210 ± 232 steps/day) to week 1. A similar, significant increase in average daily steps was found between baseline and all other weeks of the intervention ($p < 0.001$). Perceived social support and self-regulation significantly improved between baseline and the end of the study ($p < 0.05$), but self-efficacy and outcome expectations did not change ($p > 0.05$). **CONCLUSION:** These results suggest that a Blackboard Learn Internet-technology intervention can significantly increase walking by nearly

2,000 steps/day from baseline, as well as enhance social support and self-regulation among sedentary/insufficiently active university faculty and staff.

Introduction

Even though research clearly shows that regular physical activity promotes wellness and reduces the risk of several adverse health conditions, only half of U.S. adults report meeting the current aerobic physical activity guidelines set forth in the *2008 Physical Activity Guidelines for Americans* (≥ 150 minutes/week of moderate-intensity aerobic physical activity, or ≥ 75 minutes/week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic physical activity in bouts of at least 10 minutes) and nearly 30% of U.S. adults are inactive.^{1,2} Unfavorable health consequences are linked to physical inactivity, and the economic cost of an inactive lifestyle among Americans is substantial.^{1,3} As health care expenditures rise⁴ and with the recent adoption of the Affordable Care Act,⁵ there is an increasing interest in establishing comprehensive worksite wellness programs in order to improve health outcomes for large numbers of at-risk individuals while lowering costs.⁶⁻⁸ Given these facts, the value of pinpointing effective workplace physical activity promotion efforts is evident.

Physical activity interventions can be administered through various mediums, including the Internet.⁹⁻¹² The Internet is an attractive delivery method for physical activity interventions centered on different populations and settings, including faculty and staff who work in higher education. It has an extraordinary reach as evidenced by the fact that 87% of U.S. adults use the Internet.¹³ Plus, university faculty and staff typically have free Internet access at their worksite. Easy access, convenience, novelty, timely feedback, a high level of anonymity if desired, low

cost, and the ability to easily distribute materials, are additional advantages of using the Internet to administer a behavior change intervention.¹⁴⁻¹⁶

Several Internet-based physical activity promotion studies,¹⁷⁻³¹ including those centered on university faculty and staff,^{32,33} have reported promising findings. However, delivering Internet-based physical activity interventions often times requires specialized skills and expertise. The use of course-related Internet technology (e.g., Blackboard LearnTM), which is already in place at many universities, represents one possible solution to this problem. It is easy to learn and has a number of features that can be used to create a comprehensive, interactive physical activity intervention. Yet, to our knowledge, only three published studies have used course-related Internet technology to deliver a physical activity intervention.³⁴⁻³⁶ While these studies showed statistically significant improvements in terms of physical activity, they only focused solely on college students, and two of them^{34,35} used self-reported measures of physical activity.

Thus, the primary purpose of this pilot study was to examine the efficacy of a course-related Internet-technology intervention grounded in social cognitive theory (SCT)³⁷ for increasing pedometer-measured step counts in a sample of university faculty and staff. A secondary purpose of this study was to analyze the impact of the intervention on presumed mediators (social support, self-efficacy, self-regulation, and outcome expectations) of physical activity behavior change.

Methods

Study Design

This study used a single-group, pretest, posttest design. Participants were enrolled in an Internet-mediated walking program based at the University of Tennessee (Knoxville, TN) lasting

from September 2012 to December 2012. The study was approved by the Institutional Review Board at the University of Tennessee, Knoxville, TN. The main outcomes included pedometer-measured step counts, social support for exercise, self-efficacy for exercise, self-regulation for exercise, and outcome expectations for exercise.

Participants

University of Tennessee (Knoxville, TN) faculty and staff members were recruited via flyers placed around campus (see Appendix A), mass e-mails distributed via listservs (see Appendix A), an announcement placed in a University of Tennessee electronic newsletter (see Appendix A), and word of mouth. Participants were eligible if they were sedentary or insufficiently active ($\leq 7,499$ steps per day),³⁸ between the ages of 18 and 64 years, able to walk at least 1/4 mile without stopping, had a body mass index between 18.5 kg/m^2 and 34.9 kg/m^2 , expressed comfort using a computer to access the Internet, and had access to the Internet via a computer. Participants were excluded if they reported being a smoker, were currently participating in a program to increase physical activity, were pregnant or planning to become pregnant, had a resting blood pressure greater than 180 mmHg systolic and/or 100 mmHg diastolic, had an implanted pacemaker or defibrillator, or reported a medical or physical contraindication or limitation for engaging in a walking program.

Eligibility Screening, Consent, and Baseline Assessment

Interested persons were initially screened by telephone to ascertain eligibility. Individuals who passed this screening reported to the Applied Exercise Physiology Laboratory at an individually scheduled time. They were instructed not to eat or drink (except water) within four hours of their appointment and to avoid exercise within 12 hours of their appointment. Upon arrival, they signed the written informed consent (see Appendix A) and completed a

standard health history form (see Appendix B) and the physical activity readiness questionnaire³⁹ (see Appendix C). Each participant completed an online baseline assessment survey. This survey included questions about Internet access and comfort using a computer to access the Internet, as well as demographic information (see Appendix D), self-reported physical activity (see Appendix E), social support for exercise⁴⁰ (see Appendix F), self-efficacy for exercise⁴¹ (see Appendix G), outcome expectations for exercise⁴² (see Appendix H), and self-regulation for exercise⁴³ (see Appendix I). Subsequently, participants underwent measurements of resting blood pressure, anthropometric indicators, and body fat percentage (bioelectrical impedance analysis technique). All measures were administered by one investigator (C.M.).

Following the laboratory-based assessments, participants were given an Omron HJ-720ITC pedometer (Omron Healthcare, Inc., Lake Forest, IL). This pedometer is equipped with a dual-axis accelerometer, stores 41 days of step count data in its memory, and displays the most recent seven days of step count data. This device is valid and reliable for measuring steps during various walking speeds, while mounted in different positions (right pocket, left pocket, and three waist-mounted sites).⁴⁴ Participants were asked to wear the pedometer for seven consecutive days during all waking hours (except when swimming or showering). They were instructed to wear it in the front pants pocket or clip it to the pants at the waistline. Participants were told to engage in their usual activities, and the pedometer displays were covered by a piece of tape to prevent the participants from viewing their step counts. Upon completion of this one-week, baseline assessment, the participants returned to the Applied Exercise Physiology Laboratory at individually scheduled times. The primary investigator (C.M.) uploaded the participants' step count data and calculated an average daily step count for the baseline week, which was used in part to confirm that the participants were inactive/insufficiently active ($\leq 7,499$ steps/day). Then,

eligible participants were enrolled in and introduced to an Internet-based walking program using rolling enrollment during September and October, 2012.

Intervention

Participants engaged in an eight-week walking intervention called UTMoves. They were instructed to wear their pedometers everyday for the eight-week intervention during waking hours (except when swimming or showering). They were given the recommendation to walk at least 3,000 steps/day above their personal, average daily baseline step count on at least five days each week. This recommendation is roughly equivalent to the current physical activity recommendation for moderate-intensity activity¹ if the additional 3,000 steps/day goal is achieved in a 30-minute time frame.^{1,45} They were encouraged to gradually reach this goal, targeting at least 1,000 steps/day above their average daily baseline step count on at least 5 days during the first week, followed by a goal of at least 2,000 steps/day above their average daily baseline step count on at least 5 days during the second week. Finally, they were asked to focus on attaining at least 3,000 steps/day above their average daily baseline step count on at least 5 days each week during the remainder of the study (week 3 through week 8). Participants were encouraged to accumulate steps through a lifestyle approach, meaning that they were instructed to accumulate steps in ways that best fit their lifestyles. They were given examples of how to increase daily steps (e.g., walk rather than drive around campus; walk during lunch breaks), but no specific approach was required.

During the eight-week intervention, participants were granted access to a supportive website (UTMoves website) that was created using the Blackboard Learn platform in order to help them achieve their step goals. Blackboard Learn is a course management, technology application. Instructors at the University of Tennessee can use this program to deliver online

courses or as a supplemental tool for a traditional, classroom-based course. It is flexible, easy to use, and has a number of dynamic features that make it suitable for the delivery of a walking intervention. Participants logged in to Blackboard Learn and subsequently the UTMoves site using their university username and password. They were asked to view a brief video tutorial and read online instructions the first time they logged in to the website. Both the tutorial and instructions handout provided an overview of the walking program and reiterated how to use the UTMoves website. The website was comprised of components and content rooted in the SCT,³⁷ and thus, designed to target presumed mediators of physical activity behavior change (i.e., self-regulation, self-efficacy, social support, and outcome expectations).

In particular, participants had access to and were encouraged to view weekly folders, which were comprised of informational handouts, videos, articles, and links to relevant Web resources centered on particular topics. Physical activity recommendations, goal setting, self-monitoring, rewards for goal achievement, pre-planning, relapse prevention, overcoming barriers to being physically active, benefits of physical activity, strength training, flexibility, and overall wellness represented the topics that were covered. Participants also had access to a discussion board and could participate in three live chats that were offered during the course of the intervention. These two features were designed to directly foster social support for physical activity. They served as venues where participants could communicate with each other. Participants were asked to enter the discussion board a minimum of three times each week to view and draft posts. The primary investigator (C.M.) also drafted posts to facilitate discussions. The scheduled live chats were characterized by an online chat room in which synchronous discussions occurred via typed text only. The primary investigator (C.M.) moderated each live chat session.

Participants were asked to log their daily steps and physical activity via an online physical activity log. This log was developed using the test function of Blackboard Learn and promoted self-monitoring. Participants answered the same questions each day, which asked them to report their steps for the day, the strategies they used to achieve those steps, and the types of physical activities they engaged in other than walking or running. The primary investigator (C.M.) analyzed the participants' online logs at the end of each week and gave them personalized, weekly feedback regarding their progress via e-mail. Separate, general reminders centered on logging activity and participating in the discussion board and live chats, as well as a weekly motivational tip, were posted on the homepage of the UTMoves website. Participants could contact the primary investigator by sending an e-mail from the website if they had any questions or concerns related to technical or clarification issues.

Post-intervention Assessment

At the end of the eight-week intervention, participants repeated the following measures: self-reported physical activity, self-regulation for exercise, self-efficacy for exercise, social support for exercise, outcome expectations for exercise, weight, waist circumference, and body fat percentage. They also completed an online satisfaction questionnaire (see Appendix J), which addressed their thoughts regarding the acceptability and usefulness of the overall intervention. Only participants who completed the post-intervention assessment were included in the final analyses.

Measures

Average daily step counts

Participants reported their daily Omron-measured steps during the eight-week intervention via an online physical activity log embedded in the UTMoves website. Based on

these reported steps, an average daily step count was calculated for each week of the intervention. If participants reported a step count of < 100 steps/day²⁶ or noted that they did not wear the pedometer most of the day, then such step counts were not included in the averages. All other reported step counts were considered valid. In order to calculate an average daily step count for any given week, at least 3 days/week of valid step count data were required.⁴⁶

Self-regulation for exercise

Participants' self-regulation for exercise was measured using The Exercise Goal-Setting scale (EGS) and The Exercise Planning and Scheduling scale (EPS) (see Appendix I).⁴³ Each respective questionnaire contains 10 items that participants rated on a 5-point scale ranging from 1 (does not describe) to 5 (describes completely). The item scores were averaged to obtain a final score for each questionnaire. Higher scores indicate a stronger propensity for exercise goal setting and exercise planning.

Self-efficacy for exercise

Participants' self-efficacy for exercise was measured using The Barriers Self-efficacy scale (see Appendix G).⁴¹ This questionnaire contains 13 items that measure participants' perceived ability to exercise three times a week for 40 minutes for the next three months when confronted with barriers to participating in exercise. Participants rated the items on an 11-point scale ranging from 0 (not at all confident) to 10 (highly confident). The item scores were summed and the total score was divided by the total number of items, which yielded the final self-efficacy for exercise score (possible range of scores from 0 to 10). Higher scores indicate a stronger perceived ability to exercise when faced with barriers to exercise.

Social support for exercise

Participants' social support for exercise was measured using The Family and Friend Support for Exercise Habits scale (see Appendix F).⁴⁰ This questionnaire contains 13 items. Participants rated each item twice (once for perceived social support for exercise from family and once for perceived social support for exercise from friends) on a 5-point scale ranging from 1 (none) to 5 (very often). The item scores were averaged to obtain a final score for each questionnaire. Higher scores indicate a stronger sense of social support for exercise from family and friends. The questionnaire also contains a "does not apply" option for each item. Participants who marked "does not apply" for one or more items were removed from the analysis for the respective variable(s).

Outcome expectations for exercise

Participants' outcome expectations about the benefits of exercise were measured using The Multidimensional Outcome Expectations for Exercise Scale (see Appendix H).⁴² This questionnaire contains 15 items that encompass three subdomains (physical, social, and self-evaluative outcome expectations). Participants rated each item on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The items belonging to each subscale were averaged, resulting in three separate total scores (one for each subdomain). Higher scores reflect stronger beliefs in the benefits of exercise.

Self-reported physical activity

Participants' current level of physical activity was assessed using the International Physical Activity Questionnaire⁴⁷ (IPAQ-short form) (see Appendix E). This questionnaire asks participants to report the volume (number of days/week and minutes/day) of vigorous-intensity physical activity, moderate-intensity physical activity, and walking they performed in bouts of at

least 10 minutes at a time during the past seven days. A separate physical activity (MET-min/week) value was calculated for each of the three intensities of physical activity (vigorous-intensity, moderate-intensity, and walking), and these three scores were summed to provide a total MET-min/week value. Participants who reported that they did not know or were not sure about the volume of vigorous-intensity, moderate-intensity, and/or walking they performed were removed from the analysis of this variable.

Physical characteristics

Each participant's height and weight was measured (in light clothing and without shoes and socks) using a standard wall-mounted stadiometer and an electronic scale (Tanita Body Composition Analyzer, Model BC-418), respectively. BMI was calculated by dividing weight (kg) by height (m) squared. Waist circumference was measured with a Gulick spring-loaded tape measure. Two measurements were taken at the narrowest part of the torso (above the umbilicus and below the xiphoid process),⁴⁸ and the average of the two measurements served as the final waist circumference value. Body fat percentage was measured (in light clothing and without shoes and socks) using a bioelectrical impedance analyzer (Tanita Body Composition Analyzer, Model BC-418).

Website access

Each time a participant logged in to the UTMoves website, it automatically generated a time stamp. This information was used to objectively track the date and number of times each participant logged in to the UTMoves website.

Discussion board and live chat use

When a participant drafted a message (a new one or a reply to another participant's message) on the discussion board it was counted as a "post." Participants also self-reported how

often they accessed the discussion board to view posts by other participants during the course of the study as part of the online questionnaire that was administered during the post-intervention assessment. They selected one of the following choices: “Never,” “Less than one time per week,” “Weekly,” “Several times per week,” or “Daily.”

The primary investigator (C.M.) recorded the number of participants who engaged in each one of the three live chat sessions.

Data Analysis

SPSS version 20.0.0 for Windows (SPSS Inc., Chicago, IL) was used for the statistical analyses. Descriptive statistics were calculated for all baseline measures. A repeated measures ANOVA was used to compare weekly average daily step counts. For a significant effect, pairwise comparisons, using Bonferroni corrections, were conducted at each time point to determine when the differences occurred. Paired *t* tests were calculated to compare mean pretest and posttest values for all psychosocial variables, weight, BMI, and body fat percentage. A Wilcoxon test was used to compare the median pretest and posttest total MET-min/week values calculated from the IPAQ. Means and standard deviations were reported for continuous variables with a normal distribution. Medians and interquartile ranges (IQR) were reported for continuous variables with a non-normal distribution. Percentages were reported for categorical variables. Spearman correlation coefficients were calculated to assess relationships among change in daily step counts (steps/day), change in psychosocial variables, website access variables, and discussion board use variables. The change in daily step counts variable was calculated by computing a mean daily step count across the entire intervention period, using the average daily step count for each week. The difference between this value and the average daily baseline step count represented the change in daily steps. The change in each one of the

psychosocial variables was calculated using each respective variable's baseline and post-intervention values.

Descriptive statistics were also calculated for measures of web access (means and standard deviations), discussion board use (mean and standard deviation, median and IQR, and frequency counts), live chat use (frequency counts) and satisfaction (percentages).

An alpha level of 0.05 was selected to indicate statistical significance.

Results

Recruitment

A total of 130 potential participants underwent the initial telephone screening, and 43 passed this screening and completed the laboratory-based screening process. Forty-one individuals' eligibility was confirmed, and 38 individuals ultimately enrolled in the study (Figure 1.1).

Baseline Characteristics

Participants' ages ranged from 22 to 63 years (mean age = 48.8 ± 10.1 yr). The sample was slightly overweight (mean BMI = 27.3 ± 3.9 kg/m²) (Table 1.1 and Table 1.2). Most participants were Caucasian, women, staff members, and had access to the Internet at home. All of the participants had Internet access at work (Table 1.1).

Average Daily Step Counts

Table 1.3 shows changes in Omron-measured average daily steps across each week for subjects who reported a sufficient number of valid daily step counts each week to allow for the calculation of an average daily step count across each week of the intervention. Participants (n = 33) significantly increased their average daily steps between baseline and each intervention week ($p < 0.05$). A mean increase of 1803 ± 240 steps/day ($p < 0.05$) was observed from baseline

(5210 ± 232 steps/day) to week 1 ($p < 0.05$). A similar, significant increase in average daily steps was found between baseline and all other weeks of the intervention ($p < 0.05$).

Social support for exercise

Participants' ($n = 35$) perceived social support for exercise from friends significantly increased from baseline to the end of the intervention ($p < 0.05$). Their ($n = 31$) perceived social support for exercise from family significantly increased from baseline to the end of the intervention ($p < 0.05$). Subjects were excluded from these analyses if they marked the “does not apply” option for one or more of the questionnaire items, resulting in different sample sizes for each respective analysis (Table 1.4).

Self-efficacy for exercise

There was no significant difference in participants' ($n = 36$) self-efficacy for exercise between baseline and the end of the intervention ($p > 0.05$) (Table 1.4).

Self-regulation for exercise

Participants' ($n = 36$) exercise goal setting and exercise planning both significantly increased from baseline to the end of the intervention ($p < 0.05$) (Table 1.4).

Outcome expectations for exercise

There was no significant difference in participants' ($n = 36$) outcome expectations for exercise in terms of the three subdomains (physical, social, and self-evaluative) between baseline and the end of the intervention ($p > 0.05$) (Table 1.4).

Self-reported physical activity (total MET-min/week)

Participants ($n = 26$) significantly increased their self-reported physical activity from baseline to the end of the intervention ($p < 0.05$) (Figure 1.2). Initial reported physical activity

was 239.3 (IQR: 61.9 to 742.1 MET-min/week). This increased to 1145 (456 to 1740 MET-min/week).

Physical characteristics

Although there was a slight, but significant increase in weight, and thus, BMI ($p < 0.05$) from baseline to the end of the intervention among the sample ($n = 36$), there was no significant change in percent body fat or waist circumference ($p > 0.05$) (Table 1.2).

Website access

The mean number of log-ins per person per week to the UTMoves website was 3.3 ± 1.8 . ($n = 36$) Participants logged-in to the UTMoves website an average of 2.8 ± 1.5 days per week.

Discussion board and live chat use

Of 36 participants, 72% drafted at least one discussion board post, 61% drafted more than one post, and 25% drafted more than 10 posts. The average number of posts per participant was 8.6 ± 17.4 . They drafted a median of 3 posts (IQR: 0.0 to 10.8 posts). All of the participants, with the exception of one, reported accessing the discussion board to read other participants' posts (13 of the 36 participants reported doing so less than one time per week, 12 reported doing so weekly, 9 reported doing so several times per week, and 1 reported doing so daily).

A total of five participants engaged in at least one live chat session (3 participants engaged in the first session, one engaged in the second session, and 3 engaged in the third session).

Spearman correlation coefficients

Table 1.5 provides the Spearman correlations among change in daily step counts, change in psychosocial variables, website access, and discussion board use. Of note, significant, positive relationships were found between the change in daily steps and the following three

variables: log-ins per week ($r = 0.42$; $p = 0.012$), number of days logged-in per week ($r = 0.37$; $p = 0.028$), and discussion board posts ($r = 0.37$; $p = 0.029$). Self-reported frequency of accessing the discussion board to view other participants' posts was significantly and positively correlated with the following three variables: log-ins per week ($r = 0.40$; $p = 0.016$), number of days logged-in per week ($r = 0.38$; $p = 0.025$), and discussion board posts ($r = 0.54$; $p = 0.001$). A significant, positive correlation was observed between the change in exercise planning and discussion board posts ($r = 0.35$; $p = 0.037$). No significant relationships were found between the change in daily step counts and the change in any of the psychosocial variables.

Satisfaction

Participants found the intervention to be highly acceptable. Based on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree), 92% of the participants agreed or strongly agreed that the study website was easy to use/navigate. All of the participants agreed or strongly agreed that they were satisfied with the online walking program, and 97% agreed or strongly agreed that they would recommend it to a friend, co-worker, and/or family member.

Discussion

This pilot study examined the efficacy of a SCT-based³⁷ walking intervention delivered via course-related Internet technology for increasing steps among sedentary/insufficiently active university faculty and staff. An additional aim was to evaluate changes in presumed mediators of physical activity behavior change. The results indicate that the intervention was successful at significantly improving average daily step counts, social support, and self-regulation (exercise goal setting and planning); however, it failed to have a significant impact on self-efficacy or outcome expectations.

An approximate 1,800 step/day increase (slightly under one mile)⁴⁹ was observed between baseline and each intervention week. This finding is similar to previous pedometer interventions.^{25,26,32} Bravata et al.⁴⁹ conducted a meta-analysis of pedometer-oriented physical activity promotion studies and found an overall increase of about 2,000 steps/day above baseline among the studies' pedometer users. The participants in the reviewed studies were collectively similar to the present sample (predominantly middle-aged, overweight, Caucasian women who were insufficiently active at baseline). Two short-duration (6 weeks²⁵ and 16 weeks²⁶) Internet-based physical activity promotion studies targeting insufficiently active adults, which were published after Bravata et al.'s meta-analysis,⁴⁹ also reported an approximate 2,000 step/day increase from baseline among all study participants. Haines et al.³² implemented a 12-week walking intervention for university faculty and staff. Participants completed a computer-based educational program, received weekly tips via e-mail, wore a pedometer, and logged their daily steps. The magnitude of increase in daily steps from the beginning to the end of the intervention was also around 2,000.

In concordance with the observed increase in daily steps, the present sample's self-reported physical activity significantly increased from a median of 239 MET-min/week at baseline to a median of 1145 MET-min/week at the end of the intervention. That is, participants' reported baseline and post-intervention level of physical activity roughly equates to 10 min/day and 50 min/day, respectively, of moderate-intensity physical activity (i.e., walking at 3 miles/hour).¹ Several Internet-based physical activity promotion studies have also observed significant improvements in self-reported physical activity among various populations,^{17,19-24,27-31} including university faculty and staff.³³

The use of a course-based Internet technology platform (Blackboard Learn) as the medium for the delivery of the physical activity intervention represents the advantageous aspect of the present study versus other Internet-based studies. Given that this platform is already established and user-friendly, the design and administration of the UTMoves website did not necessitate specialized Web-based knowledge and skills. Its wide array of features and tools also allowed for the delivery of a dynamic and comprehensive intervention.

To date, only three other published studies have used course-based Internet technology for the delivery of a physical activity intervention.³⁴⁻³⁶ Magoc et al.³⁴ conducted a randomized controlled trial, using this medium to deliver a six-week intervention comprised of online lessons rooted in the SCT and an online physical activity log.³⁷ Their sample consisted of inactive college students. The authors found a significant increase in reported moderate and vigorous days of physical activity over the past week among the intervention group relative to the control group. Grim et al.³⁵ carried out a three-group, quasi-experimental study. They compared the effect of three different university courses on college students' physical activity. One group of students was enrolled in a course delivered through course-based Internet technology. They completed SCT-based lessons and a weekly online physical activity log. Another group participated in a traditional, in-person physical activity promotion course. A third group completed a traditional, in-person general health course. The authors found a significant increase in reported vigorous days of physical activity over the past week among the Internet-based and traditional physical activity groups relative to the health group. Ornes et al.³⁶ conducted a one-month randomized control trial, assigning college-aged females to one of three groups. One group wore a pedometer and gained access to a course-based Internet website comprised of SCT components. A second group wore an unsealed pedometer and recorded their

steps. A third group wore a sealed pedometer. The latter two groups were combined for the statistical analysis. The intervention group achieved a significantly higher number of steps per day during each week compared to the controls. In contrast to Magoc et al.,³⁴ Grim et al.,³⁵ and Ornes et al.³⁶ the present study targeted university faculty and staff; thus, the findings uniquely enhance the preliminary evidence supporting the use of course-based Internet technology as a medium for the successful promotion of physical activity.

In addition, tracking how often participants accessed the UTMoves website allowed for a measure of website engagement.⁵⁰ The average number of log-ins to the UTMoves website was 3.3 per participant per week. A meta-analysis of Internet-delivered, physical activity promotion studies reported a similar finding, noting that among the 11 studies that reported this outcome, the average number of log-ins was 3.08 per person per week.⁵⁰ Findings from previous Internet-based health behavior change research indicate that increasing participants' engagement in a website is directly associated with increased intervention exposure, and in turn, favorable changes in behavior.^{19,51-54} The findings from the present study support this notion. That is, participants who accessed the website more often experienced a greater improvement in daily steps relative to participants who accessed the website less often. McKay et al.¹⁹ carried out an eight-week, Internet-based physical activity intervention targeting sedentary patients with type 2 diabetes. The online program was designed to facilitate goal setting, planning for physical activity, feedback, and communication with a personal coach and peers. They also found that those in the intervention group who logged-in to the website more regularly experienced significantly greater improvements in physical activity compared to those who logged-in to the website less frequently. Previous research has suggested that interactive website features, such as platforms for peer or counselor support and online physical activity logs, may facilitate

increased website engagement and subsequent increased intervention exposure in Internet-delivered health behavior change programs.^{55,56}

Such theory-based intervention elements, which are designed to target presumed mediators of physical activity behavior change, were part of the present intervention. These elements, along with other theory-based intervention components, may help explain the observed increase in step counts and reported physical activity. Improvements in two SCT constructs (i.e., self-regulation and social support) lend support to this assertion. As noted earlier, other pedometer-centered studies have also found significant improvements in steps,^{25,26,32,49} and Bravata et al.⁴⁹ stated that the use of pedometers, a step goal, and a step diary may be key factors for increasing physical activity. These elements, as well as informational resources centered on exercise planning and goal setting, were central features of the present intervention and may have led to greater self-regulatory behaviors among the sample. The observed increase in reported self-regulation (exercise goal setting and planning) among the sample is in line with this notion. While there was not a significant correlation between the change in self-regulation behaviors and the change in steps based on the available measure that was used to assess self-regulation, positive changes in self-regulation have been linked to favorable changes in physical activity in previous research, including Internet-based physical activity promotion studies.^{35,49,57-}

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Likewise, the discussion board, feedback, and the social support-related informational resources, may have led to the reported improvements in perceived social support. Although the live chats were also designed to foster social support, only five of the 36 participants took advantage of this feature, so it likely did not play a role in terms of the overall study outcomes. However, the participants who engaged in the live chats anecdotally stated they found it helpful

and easy to use at the post-intervention assessment. One of the inherent issues associated with the live chat function used in this study is that the chats had to be scheduled at fixed times. This factor may partially explain why few participants engaged in the live chats. If they had a scheduling conflict (e.g., work-related task) or could not access a computer at the scheduled time, then they would not be able to participate. Offering more live chat sessions at varied times or having a function that allows users to initiate their own live chats (e.g., instant message application) may be a few ways to help address this issue.

Conversely, 72% of the sample made at least one discussion board post and 61% made multiple posts. During the course of the study, participants drafted 8.6 posts on average and a median of 3 posts. All of the participants except one reported accessing the discussion board to read other participants' posts (63% did so \geq one time per week). In fact, participants who accessed the discussion board to read other participants' posts more frequently had a higher number of log-ins compared to those who read others' posts less frequently. These findings collectively suggest that a discussion board may have the ability to facilitate increased website engagement, which supports the notion mentioned earlier regarding the potential link between interactive website features and enhanced engagement.

Richardson et al.²⁶ also noted that their online community was active albeit to a lesser extent than the current study. They compared the effect of two Internet-based walking interventions (one with an online community group and one without an online community group) on step counts over 16 weeks. Their sample was comprised of sedentary adults who were overweight, had type 2 diabetes, and/or coronary artery disease. Out of 254 participants who were randomized to the online community group, 45% drafted at least one online community post.⁶⁰ On average, there were 5 posts per person and a median of 2 posts per person over the

course of the study.⁶⁰ In addition, 20% of the 254 participants never made a post, but viewed an average of at least one online community forum page per week.⁶⁰ Only 5% (12/254) never viewed a forum page.⁶⁰ Both groups significantly increased their average daily steps between baseline and the end of the intervention period, but there was no significant difference between the two groups. On average, a 1,888 step count increase was observed across both groups. The percentage of completers was significantly higher in the online community group compared to the no online community group, and online community group participants engaged in the program longer than the no online community group participants.²⁶

However, some research conflicts with the aforementioned observed online community use findings. Reviews of online health interventions have noted that online communities are often times plagued by low user activity.^{61,62} Thus, finding ways to maximize participant use is one challenge going forward. Richardson et al.⁶⁰ reflected on factors that may enhance participants' use of online communities, including the display format, posting contests, and staff input. Building upon existing social ties or online community affiliations may be another way to enhance engagement in an online community.^{26,62}

Identifying ways to maximize online community use is worthy of future exploration given that participants in the current study and Richardson et al.'s study²⁶ who drafted more posts on the discussion board experienced significantly greater increases in daily steps compared to those who drafted fewer posts. Richardson et al.²⁶ also found a significant, positive correlation between viewing of posts and step counts among the intervention group. In both the present study and Richardson et al.'s²⁶ study, the participants used the discussion board to share their challenges and successes, provide encouragement, and offer helpful suggestions. Participants in the present study also posted pictures of their physical activity. Thus, perhaps the discussion

board especially fostered social support via informational support, esteem support, emotional support, and social modeling.⁶³⁻⁶⁶ A significant association between the change in social support and the change in daily steps was not found based on the available measure of social support, which only addressed support from friends and family (not online sources). Yet, favorable levels of social support have been positively linked to physical activity behavior among different populations in previous research^{35,57, 64,65-73} One of the ways an increased perception of social support for physical activity has been shown to favorably impact physical activity is through its impact on levels of self-regulation.^{70,74} In line with this notion, greater use of the discussion board in the present study was associated with a greater improvement in self-regulation.

Even though certain intervention features (i.e., informational materials, motivational tips, feedback, and discussion board) also targeted two other SCT constructs that have been linked favorably to physical activity behavior (i.e., outcome expectations and self-efficacy),^{73,75} there are a few possible reasons why these constructs did not change. For example, the sample reported high outcome expectation beliefs at baseline, and thus, the ability to improve this variable was constrained. Significant improvements may have been observed among the sample if their outcome expectation beliefs had been low at baseline.³⁴ Moreover, perhaps insufficiently active persons do not have the necessary background to make accurate self-efficacy judgments, and therefore, go through a recalibration of their self-efficacy after engaging in a physical activity program.⁵⁸ This would make it difficult to determine whether or not self-efficacy is actually changing.

An increase in body mass of 0.5 kg was observed among the sample, resulting in a slight increase in BMI; however, the participants maintained their waist circumference and body fat percentage. A number of factors may explain these findings. First, this intervention did not

focus on diet, which is a key factor in terms of achieving and maintaining a healthy weight and body composition.^{1,76-79} Other short-duration programs centered only on exercise have observed similar findings.^{76,80} Second, the exercise prescription was inadequate for weight loss. According to the *2008 Physical Activity Guidelines for Americans*, for weight maintenance and substantial (more than five percent of body weight) weight loss via physical activity alone, a high volume of physical activity (≥ 300 minutes/week of moderate-intensity physical activity) may be needed.¹ However, the prescribed step goal was roughly equivalent to the recommended volume of activity needed to achieve most health benefits (≥ 150 minutes/week of moderate-intensity physical activity).¹ Third, this study took place over the course of the late fall and early winter. Research has shown seasonal variation in body mass, with a higher value being common during the winter.⁸¹ Despite the minimal anthropometric and body fat changes, the observed increase in daily steps is still noteworthy from a health standpoint because an increase in physical activity can lead to a number of other beneficial health outcomes independent of changes in these variables.¹

In addition to being one of the few studies to use course-based Internet technology for physical activity promotion, this pilot study has a few other notable strengths. In particular, it was characterized by elements based on an established behavior change theory (SCT).³⁷ The use of objective log-in data as one indicator of website engagement, as well as the use of two measures of physical activity (pedometer-measured steps and self-reported physical activity), represent two additional strengths of this study. Based on reviews^{50,82} of studies centered on Internet-based physical activity interventions, only self-report physical activity measures have typically been employed. The observed increases in step counts and reported physical activity, as well as the participants' overall high level of satisfaction with the intervention, suggest that

course-based Internet technology may be a viable platform for the delivery of a worksite wellness-based walking intervention in the university setting. Finding effective and acceptable ways to promote physical activity in the worksite is important, considering the heightened interest in establishing worksite wellness programs that can help curb rising healthcare costs.^{4,6-8} Of note, the Blackboard Learn platform recently became publicly available at no cost via an online service called Coursesites by Blackboard™, which could potentially broaden the reach of course-based Internet technology behavior change programs.

However, it is important to acknowledge the limitations of this study. The use of a one-group, pretest-posttest design is a limitation, making it impossible to rule out factors unrelated to the intervention that may have contributed to the observed changes. Future research should use a more rigorous design (i.e., randomized controlled trial) to corroborate the present findings. Likewise, there is a need to use a more rigorous design in order to isolate the effect of specific intervention components and presumed mediators of physical activity behavior change on physical activity, which will help inform the refinement and enhance the effectiveness of Internet-based interventions.⁵⁰ Two additional limitations of this study are its short length and the small sample size. Whether or not the increase in daily steps could be maintained over the long-term is an area worthy of future exploration. This study also targeted only university faculty and staff. Thus, it would be of value to determine if such an intervention would be effective for other populations.

Conclusions

This is one of the few studies^{34,35} to examine the use of course-based Internet technology as a channel for physical activity promotion. The findings from this online walking intervention revealed significant improvements in daily steps, self-reported physical activity, self-regulation,

and social support among sedentary/insufficiently active university faculty and staff. Self-efficacy and outcome expectations did not change. These results suggest that a course-based Internet technology intervention guided by the SCT may be an effective and practical means to facilitate improvements in physical activity within the higher education setting. Additional research is needed to support and enhance the generalizability of these findings.

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Appendix

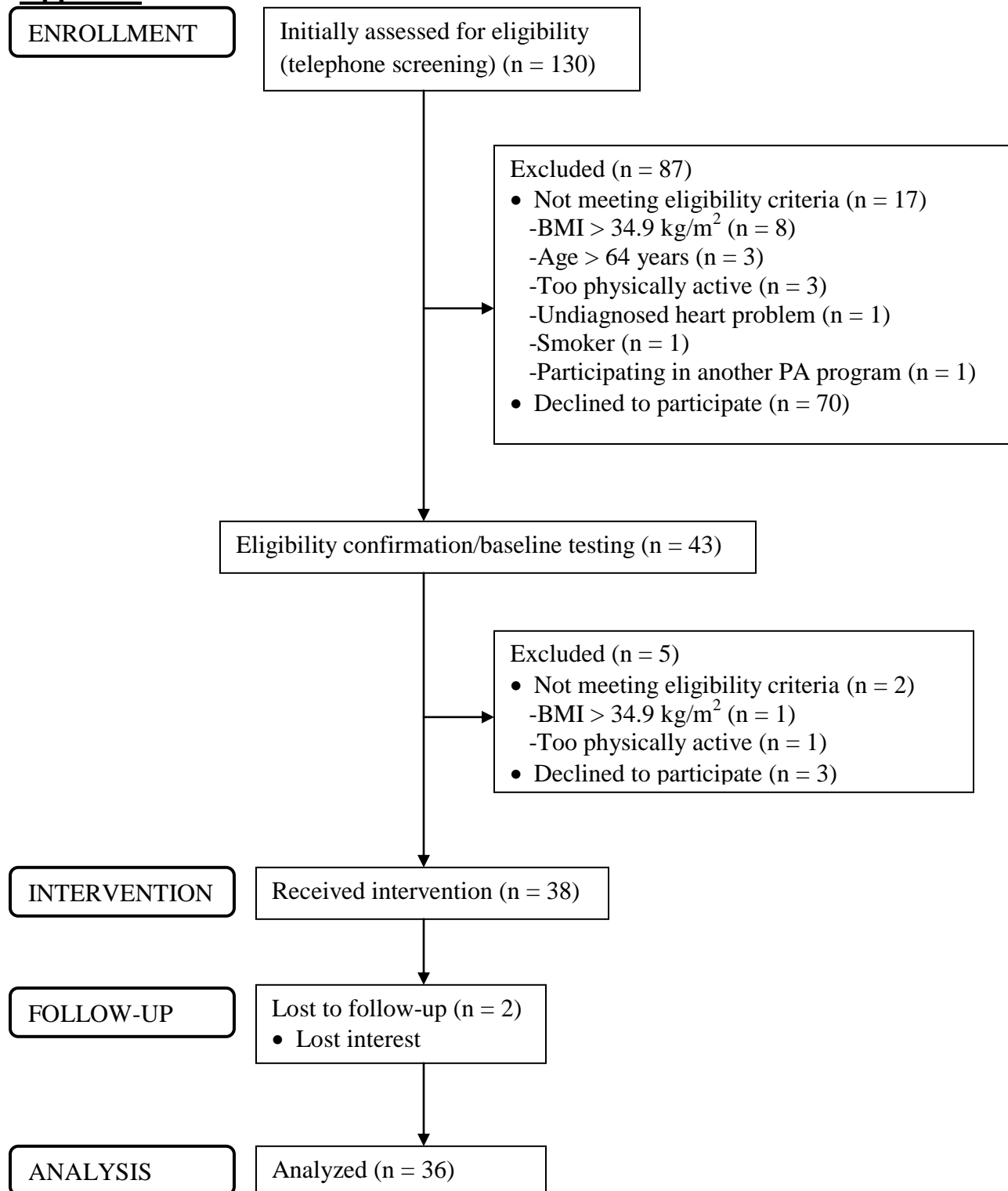


Figure 1.1. Recruitment flow sheet.

Table 1.1. Baseline characteristics of participants (N = 36)

| Measure | |
|----------------------------|-------------|
| Mean age (SD), y | 48.8 (10.1) |
| Sex | |
| Female | 83.3 % |
| Male | 16.7 % |
| Race | |
| Caucasian | 94.4 % |
| African-American | 5.6 % |
| Employment Classification | |
| Faculty | 25.0 % |
| Staff | 75.0 % |
| Education | |
| High school diploma or GED | 5.6 % |
| Some college | 13.9 % |
| Bachelor's degree | 36.1 % |
| Graduate degree | 44.4 % |
| Internet access (home) | |
| Yes | 91.7 % |
| No | 8.3 % |
| Internet usage (home) | |
| ≤ 4 times per month | 2.8 % |
| Several times per week | 19.4 % |
| Almost everyday | 22.2 % |
| Daily | 47.2 % |
| Internet access (work) | |
| Yes | 100.0 % |
| Internet usage (work) | |
| Almost everyday | 8.3% |
| Daily | 91.7% |

Note. SD = standard deviation; N = number of participants; GED = general equivalency degree.

Table 1.2. Physical characteristics (N = 36)

| Measure | Pretest Mean (SD) | Posttest Mean (SD) | <i>p</i> value |
|---------------------------|-------------------|--------------------|----------------|
| *Height, cm | 166.6 (8.1) | ----- | ----- |
| Body mass, kg | 76.0 (13.3) | 76.5 (13.8) | 0.002** |
| BMI, kg · m ⁻² | 27.3 (3.9) | 27.5 (4.0) | 0.004** |
| Waist circumference, cm | 86.8 (11.2) | 87.1 (11.2) | 0.575 |
| Body fat percentage | 35.4 (7.0) | 35.1 (6.8) | 0.084 |

Note. SD = standard deviation; N = number of participants; BMI = body mass index;

*height measured only at baseline; **statistically significant difference at $p < 0.05$.

Table 1.3. Omron-measured average steps per day across each week (N = 33)

| Week | Total steps (steps/day) |
|------|-------------------------|
| 0 | 5209.9 (1333.9) |
| 1 | 7013.0 (1601.5)* |
| 2 | 6902.0 (1531.2)* |
| 3 | 7312.7 (1518.2)* |
| 4 | 7254.8 (1622.7)* |
| 5 | 6995.5 (1935.1)* |
| 6 | 7013.6 (2023.9)* |
| 7 | 6971.0 (1705.5)* |
| 8 | 6756.0 (1456.3)* |

Note. Data represent mean (standard deviation); N = number of participants; *significantly different ($p < 0.05$) from week 0 (baseline).

Table 1.4. Psychosocial variables

| Measure | N | Pretest Mean (SD) | Posttest Mean (SD) | <i>p</i> value |
|------------------------|----|-------------------|--------------------|----------------|
| Family social support | 31 | 2.3 (0.6) | 2.6 (0.8) | 0.009* |
| Friends social support | 35 | 2.2 (0.6) | 2.6 (0.8) | 0.004* |
| Exercise self-efficacy | 36 | 5.8 (2.4) | 5.2 (2.1) | 0.187 |
| Outcome expectations | 36 | | | |
| Physical | | 4.8 (0.3) | 4.8 (0.4) | 0.683 |
| Social | | 3.2 (0.8) | 3.2 (0.9) | 1.000 |
| Self-evaluative | | 4.7 (0.4) | 4.7 (0.4) | 0.244 |
| Self-regulation | 36 | | | |
| Exercise goal setting | | 1.8 (0.8) | 2.7 (1.0) | < 0.001* |
| Exercise planning | | 1.9 (0.5) | 2.4 (0.5) | < 0.001* |

Note. SD = standard deviation; N = number of participants; Family and friends social support possible score range 1 (none) to 5 (very often); Exercise self-efficacy possible score range 0 (not confident at all) to 10 (highly confident); Outcome expectations possible score range 1 (strongly disagree) to 5 (strongly agree); Self-regulation possible score range 1 (does not describe) to 5 (describes completely); *significantly different (at $p < 0.05$).

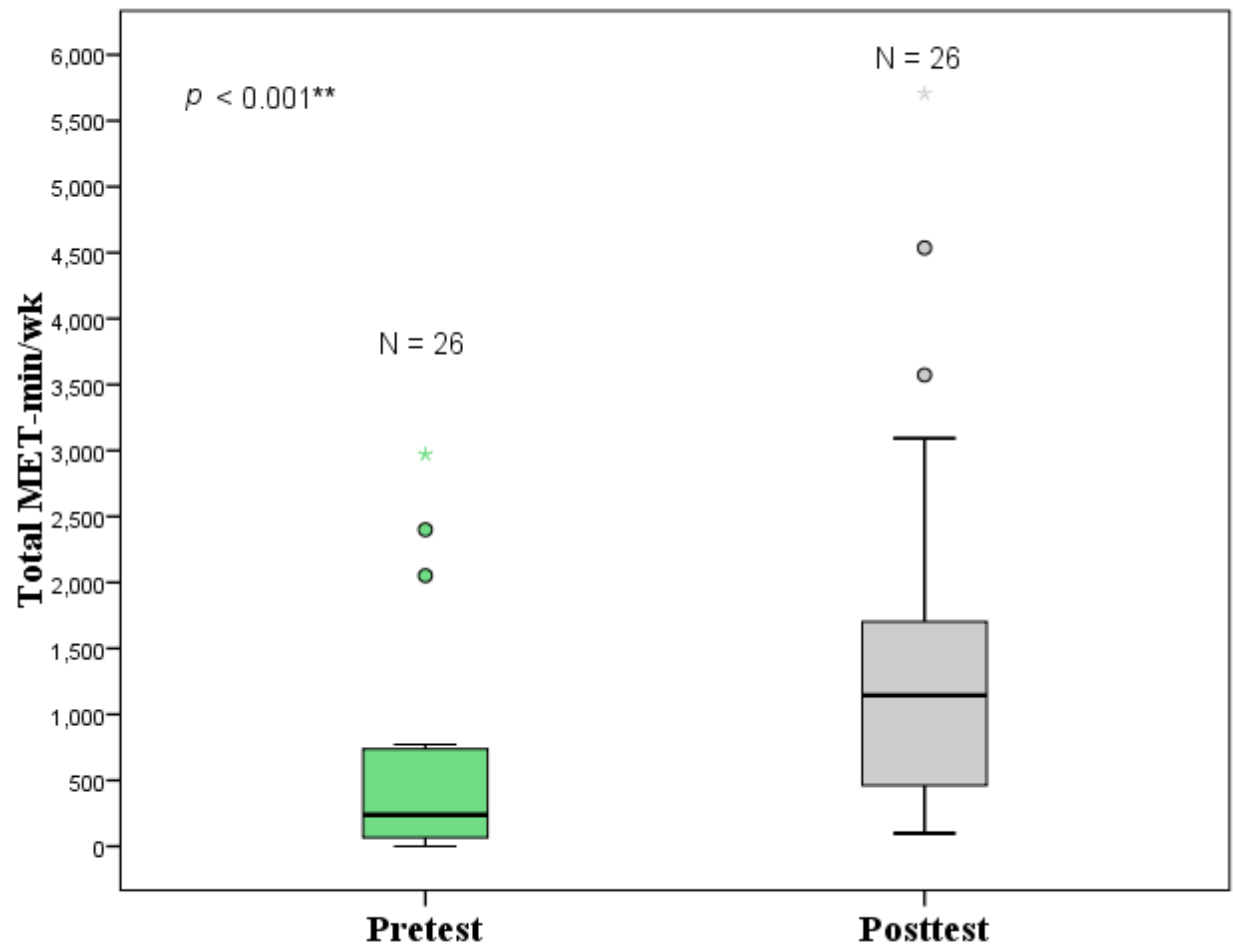


Figure 1.2. Change in self-reported physical activity. Note. MET = metabolic equivalent; ** = statistically significant difference

Table 1.5. Spearman correlation coefficients among change in daily step counts, change in psychosocial variables, website access, and discussion board use^

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---------------------------|------|------|------|-------|-------|-------|------|------|------|-------|------|-------|----|
| 1. Daily steps | - | | | | | | | | | | | | |
| 2. Family social support | .30 | - | | | | | | | | | | | |
| 3. Friends social support | .06 | .38* | - | | | | | | | | | | |
| 4. Exercise goal setting | -.16 | .17 | .05 | - | | | | | | | | | |
| 5. Exercise planning | .05 | .19 | .08 | .54** | - | | | | | | | | |
| 6. Exercise self-efficacy | .09 | -.05 | -.13 | .01 | .10 | - | | | | | | | |
| 7. Physical OE | .04 | .23 | .05 | -.14 | -.37* | .22 | - | | | | | | |
| 8. Self-evaluative OE | .18 | .32 | .25 | -.26 | -.05 | .56** | .42* | - | | | | | |
| 9. Social OE | -.03 | -.13 | -.25 | .07 | -.10 | .44** | .32 | .34* | - | | | | |
| 10. Log-ins/wk | .42* | .19 | .01 | .11 | .13 | .16 | .03 | .08 | -.18 | - | | | |
| 11. Days logged-in/wk | .37* | .17 | -.04 | .07 | .12 | .14 | .04 | .06 | -.19 | .98** | - | | |
| 12. DB posts | .37* | .24 | .26 | .32 | .35* | .06 | -.08 | -.05 | -.20 | .30 | .24 | - | |
| 13. DB views | .33 | .14 | .07 | .18 | .15 | -.18 | -.02 | -.09 | .05 | .40* | .38* | .54** | - |

Note. OE = outcome expectations; DB = discussion board; ^Sample size ranges from 30 to 36 among correlations due to missing step count data and selecting the “does not apply” option on The Family and Friend Support for Exercise Habits scale; *statistically significant at $p < 0.05$; **statistically significant at $p < 0.01$.

Part IV

Knoxville Moves: Log-in and Get Mobile

Abstract

The lack of physical activity (PA) among U.S. adults is substantial. Technologies, such as the Internet and smartphone applications are promising delivery channels for physical activity interventions targeting a large number of people. Knowing the effects of individual intervention components and presumed mediators on physical activity behavior can inform the design of future interventions. Online communities designed to foster social support have the potential to positively impact physical activity levels. **PURPOSE:** This randomized controlled trial examined the effect of providing access to online social support tools on step counts and presumed mediators of physical activity behavior change during a CourseSites™ Internet- and smartphone-mediated walking intervention rooted in the social cognitive theory (SCT).

METHODS: Sixty-three sedentary/insufficiently active adults (56 women and 7 men, 48.2 ± 10.4 y) were randomly assigned to engage in a 12-week walking intervention with or without an online social support group. Both groups received an Omron HJ-720ITC pedometer, personal steps goals, access to two websites (CourseSites, which contained SCT-components, and Omron Fitness™) and access to the Blackboard Mobile Learn™ smartphone application. The online social support group also received access to online social support tools via the CourseSites website. Participants uploaded daily steps online, and validated questionnaires were used to measure their social support, self-regulation, self-efficacy, and outcome expectations at baseline and 12 weeks. A mixed-factor ANOVA was conducted to examine changes in steps per day for participants who began the intervention ($N = 57$) and completers ($N = 46$) and to evaluate other variables of interest for completers. **RESULTS:** Using intention-to-treat analysis, there were no significant differences in the increase in daily steps between groups. Both groups significantly increased ($p < 0.001$) their daily steps from baseline (treatment: 4461.5 ± 1480.7 and control:

4630.6 \pm 1127.8) to 12 weeks (treatment: 5959.5 \pm 1811.4 and control: 7443.0 \pm 2576.8). Using completers analysis, there were no significant differences in the increase in daily steps between groups. Both groups significantly increased ($p < 0.001$) their daily steps from baseline (treatment: 4584.6 \pm 1495.2 and control: 4498.2 \pm 1128.0) to 12 weeks (treatment: 6219.7 \pm 1696.1 and control: 7424.6 \pm 2764.2). Using completers analysis, both groups' exercise goal setting and perceived social support from family significantly increased ($p < 0.05$), but there were no significant differences between groups. A significant group by time interaction was found for exercise planning ($p < 0.05$). The control group reported an increase in exercise planning, while the treatment group experienced no change. Both groups' exercise self-efficacy decreased, but there was no significant difference between groups ($p < 0.05$). No other significant relationships were found for changes in psychosocial variables ($p > 0.05$). For the treatment group, significant, positive correlations were found between the change in daily steps and online log-ins per week ($r_s = 0.60$; $p = 0.001$) and between the change in daily steps and discussion board posts ($r_s = 0.43$; $p = 0.043$). For the control group, a significant, positive correlation was found between the change in daily steps and log-ins per week ($r_s = 0.63$; $p = 0.001$). **CONCLUSION:** Providing access to online social support tools to adults randomly assigned to an exercise intervention group does not significantly enhance adherence to a walking program. When sedentary/insufficiently active adults are given access to online social support tools as part of a theory-based, technology-mediated walking program, this approach does not lead to an enhanced increase in daily steps and social support relative to an identical intervention without online social support tools. However, these tools still may be effective for certain users.

Introduction

Half of U.S. adults self-report failing to meet the aerobic physical activity guidelines detailed in the *2008 Physical Activity Guidelines for Americans* (≥ 150 minutes/week of moderate-intensity aerobic physical activity, or ≥ 75 minutes/week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic physical activity in bouts of at least 10 minutes).^{1,2} It is well-established that a lack of physical activity is associated with adverse health and economic consequences.^{1,3} Thus, finding ways to effectively promote physical activity among a large number of adults is of paramount importance. The Internet is one form of technology that can be used to deliver physical activity interventions to a large number of people at lower costs relative to more traditional delivery mediums (e.g., face-to-face and print).⁴⁻⁶ Eighty-seven percent of U.S. adults use the Internet,⁷ and it is characterized by additional advantageous features, including easy access, convenience, novelty, efficient communication and distribution of information, and the potential for users to retain anonymity.^{6,8}

Smartphones are also characterized by many of these advantages, making it another attractive form of technology for the delivery of physical activity interventions. Smartphone ownership among U.S. adults has steadily risen over the past few years from 35% in May 2011 to 58% in January 2014, and this trend is expected to continue.^{9,10} Mobile phone applications (software program designed to run on a mobile phone) represent a common feature of smartphones.¹¹ In fact, 84% of U.S. smartphone owners have downloaded an application to their phone, and exercise-related applications are the most popular type of health-related mobile application.¹² Smartphone-based physical activity promotion research is still in its infancy, but

several reviews of literature centered on Internet-based physical activity promotion studies point to the promise of this approach for favorably influencing adults' level of physical activity.¹³⁻¹⁶

Online course-based management systems represent a specific type of Internet-based platform that can be used as a channel for delivering physical activity interventions. One distinct advantage of this platform is that it contains a number of features that facilitate the easy development and administration of a dynamic website. Blackboard LearnTM is one example of such a platform. It is used at many higher education institutions, and many of its features are also widely available via a free, publicly hosted online service called CourseSitesTM. Select components of the CourseSites Internet platform can also be accessed via the Blackboard Mobile LearnTM smartphone application.

To date, just four, course-based, Internet technology, physical activity promotion studies have been conducted and none of them used a corresponding smartphone application.¹⁷⁻²⁰ These studies were grounded in the social cognitive theory (SCT) and resulted in positive changes in physical activity;¹⁷⁻²⁰ however, mixed results were found in terms of changes in presumed mediators of physical activity behavior change (i.e., social support, self-efficacy, outcome expectations, self-regulation).^{17,18,20} The effects of specific intervention components and/or presumed mediators on the change in physical activity could not be determined due to the study designs, which is typical of most Internet-based physical activity promotion studies according to published systematic reviews.^{13,14} Such information is important in order to guide the design of future interventions.¹⁵

An online community is one component that has the potential to improve participant engagement and favorably impact physical activity levels.^{20,21-27} An online community refers to a social unit that involves members who associate with each other as a group and use

communication technologies to interact and exchange information in a real-time and/or asynchronous fashion (e.g., online message board, chat room, and instant message).²⁸ They are designed to foster social support, which is a key SCT-based behavior change construct.^{29,30} Social support has been positively linked to physical activity behavior, including physical activity maintenance, among different populations in several studies.³¹⁻³⁸ It has also been positively linked to engagement in Internet-based health interventions,^{27,39,40} which is an important factor in terms of an intervention's potential effectiveness.^{14,41-44}

Online social support has been incorporated into several Internet- and smartphone-based physical activity promotion studies²¹⁻²⁷ in which a favorable change in physical activity was observed among intervention participants, including a recent pilot study²⁰ that used Blackboard as the intervention delivery medium. In this eight-week study,²⁰ perceived social support from family and friends also improved. In another study, Richardson et al.²¹ conducted a randomized controlled trial to isolate the effect of an online community as one component of a 16-week, Internet-mediated walking program on sedentary adults' step counts. They found that the increase in daily steps was not different in groups with or without online social support. They also found no significant difference in baseline and post-intervention perceived social support between the two groups. Maher et al.⁴⁵ conducted a recent review of evidence targeting the effectiveness of online social network health behavior change interventions, including studies focused on physical activity. While they found modest evidence that such interventions may be effective, they noted that there is a need to continue to conduct carefully designed randomized controlled trials and explore ways to maximize participant engagement in online communities.

Therefore, the purpose of this study was to conduct a 12-week randomized controlled trial, examining the impact of providing access to online social support tools as one part of a

course-based Internet- and smartphone application-mediated intervention grounded in the SCT on the following outcomes in a sample of adults: step counts and presumed mediators (social support, self-efficacy, self-regulation, and outcome expectations) of physical activity behavior change.

Methods

Study Design

This three-month study used a two-arm, randomized controlled trial to compare the effects of two separate Internet- and smartphone-mediated walking interventions (one with and one without online social support tools) on average daily step counts uploaded directly from a pedometer to a corresponding website, as well as reported social support for exercise, self-efficacy for exercise, self-regulation for exercise, and outcome expectations for exercise. Participants in both arms were enrolled in an identical technology-based walking program, gaining access to all the same components with one difference; the treatment or “online social support” group was given access to online social support tools (discussion board, live chat, and instant message) as part of their walking program; whereas, the control or “no online social support” group did not have access to these three online social support tools as part of their program. The trial lasted from January 2014 to July 2014 and was approved by the Institutional Review Board at the University of Tennessee, Knoxville, TN.

Participants

Sedentary and insufficiently active adults were recruited from the Knoxville community by flyers posted in public buildings (see Appendix K), mass e-mails sent through listservs (see Appendix K), a University of Tennessee electronic newsletter announcement (see Appendix K), newspaper advertisements (see Appendix K), word of mouth, and mailed letters to persons in the

Healthy Eating and Activity Laboratory Ineligible Participant Database (see Appendix K).

Participants were eligible if they had a pedometer-measured average daily baseline step count of $\leq 7,499$,⁴⁶ a body mass index between 18.5 kg/m^2 and 39.9 kg/m^2 , the ability to walk at least 1/4 mile without stopping, were 18 to 64 years of age, indicated they were comfortable using a computer to access the Internet, had Internet access, and had access to a smartphone with one of the following operating systems: iOS 6 or above or Android OS 2.3 or above. Only one member of the same household was eligible to participate. Individuals were excluded if they reported participating in another program designed to increase physical activity, being pregnant or planning to become pregnant during the length of the 12-week study, having a blood pressure ≥ 180 mmHg systolic and/or ≥ 100 mmHg diastolic, having an implanted pacemaker or defibrillator, and/or having a medical or physical contraindication or limitation for engaging in physical activity.

Eligibility Screening, Consent, and Baseline Assessment

An initial telephone screening was conducted to determine interested individuals' eligibility. Individuals who met all the eligibility criteria came to the Applied Exercise Physiology Laboratory for an individual appointment and were told to refrain from eating or drinking (except water) four hours prior to their appointment. They were also asked to refrain from exercising within 12 hours of their appointment. They signed the written informed consent (see Appendix K) and completed a standard health history form (see Appendix B) and the physical activity readiness questionnaire⁴⁷ (see Appendix C) during their appointment. Then, they filled out an online survey, which addressed their demographic information (see Appendix L), comfort using a computer to access the Internet, access to the Internet and a smartphone, and reported self-regulation for exercise (see Appendix I),⁴⁸ self-efficacy for exercise (see Appendix

G),⁴⁹ social support for exercise (see Appendix M),⁵⁰ and outcome expectations for exercise (see Appendix H).⁵¹ Next, participants' resting blood pressure, anthropometric markers, and body fat percentage (bioelectrical impedance analysis) were assessed. The principal investigator (C.M.) administered all assessments.

Upon completion of these measures, participants were asked to wear an Omron HJ-720ITC pedometer (Omron Healthcare, Inc., Lake Forest, IL) for seven consecutive days during all waking hours (except when showering or swimming). This pedometer contains a dual-axis accelerometer, stores up to 41 days of step count data, and displays the most recent seven days of step count data. Participants were told to clip it to their pants at the waistline or place it in a front pants pocket. When the pedometer is mounted at these locations, it has been shown to be both valid and reliable for measuring steps taken at various walking speeds.⁵² Participants were instructed to engage in their normal routine during this baseline assessment period. The pedometer displays were obscured, so the participants could not see their step counts. Participants returned to the Applied Exercise Physiology Laboratory at the end of this one-week baseline assessment at an individually scheduled time, so the principal investigator (C.M.) could upload their step count data and compute their average daily step count for the week. This step count was used to verify that the participants met the inactive/insufficiently active criterion (\leq 7,499 steps/day), and it was used to set step goals during the intervention.

Randomization

A computer-based random number generator was used to assign eligible participants to either the online social support arm or the no online social support arm. The allocation ratio was 1:1, using a block size of 10 with randomly varied sequences, and was not stratified. Once

randomized, participants were enrolled in the study via rolling enrollment between February and April, 2014 and introduced to their respective walking program.

Intervention

Both the treatment group and the control group participated in a 12-week walking intervention called Knoxville Moves. Participants in both groups were told to wear their pedometers on a daily basis during waking hours (except when showering or swimming) and prescribed a step goal (walk a minimum of 3,000 steps/day above the personal, average daily baseline step count on at least five days per week). This step goal is comparable to the present physical activity guidelines for moderate-intensity activity,¹ if one assumes the additional 3,000 steps/day are accumulated in a 30-minute time period.⁵³ Participants were advised to steadily progress towards this goal by aiming to accumulate at least 1,000 steps/day above their average daily baseline step count on at least five days during the first week. Then, they were instructed to achieve at least 2,000 steps/day above their average daily baseline step count on at least five days during the second week before targeting their ultimate goal of 3,000 steps/day above their average daily baseline step count on at least five days each week during the remaining ten weeks of the study. Participants were encouraged to work towards their step goals using strategies that best fit their lifestyles and provided with examples of strategies that could be employed (e.g., park farther away from facilities; walk while talking on the phone); however, they were not required to follow a certain approach.

In addition, participants in both groups were given access to two websites and a smartphone application during the duration of the study. These technologies were designed to support them in their efforts to achieve their step goals. One website, called Omron Fitness (www.omronfitness.com), corresponded with the Omron HJ-720ITC pedometer. Participants

were asked to connect their pedometer to their personal computer using a USB cable and subsequently upload their daily step counts to their personal Omron Fitness account. The step counts automatically uploaded to each participant's personal account through the Omron Fitness software driver. This freely available software was downloaded by each participant to his/her personal computer from www.omronfitness.com. Participants were encouraged to log-in to the Omron Fitness site after each upload. This website summarizes and displays users' step counts via graphs and tables, allowing them to track their progress towards their step goals.

Another website, called Knoxville Moves, was constructed using the CourseSites platform. CourseSites is a free, publicly available version of Blackboard Learn, which is a comprehensive online course creation and management service that is used in many higher education settings. CourseSites is characterized by several easy-to-use and dynamic features, making it a fitting medium for the construction and implementation of an online-based walking intervention.

Two different versions of the Knoxville Moves website were created (one for each group of participants). These versions contained identical elements, but the treatment group's version also had social support tools (discussion board, live chat, and instant message) embedded in the website; whereas, the control group's version did not have these. Participants logged into CourseSites (www.coursesites.com) using their personal username and password and subsequently accessed their version of the Knoxville Moves website by clicking on a link labeled Knoxville Moves. Each group's version of the Knoxville Moves website contained video tutorials and an online instructions handout, which described the walking program and served as a reminder about how to take advantage of the available, supportive technologies. Participants were asked to watch the tutorials and read the instructions during their first visit to the website.

Both versions of the website were characterized by SCT-based elements. More specifically, the same, weekly motivational tips were posted on the homepage of each group's version of the Knoxville Moves website. Each group was also advised to view the same weekly folders, which contained informational handouts, videos, articles, and external links to Web resources. This content addressed relevant topics, including physical activity recommendations, goal setting, self-monitoring, pre-planning, establishing incentives, preventing relapses, overcoming obstacles to being physical active, physical activity benefits, strength training, flexibility, non-traditional forms of physical activity, exercise myths, and overall wellness. Each group also had access to the same online physical activity log via their version of the Knoxville Moves website. They were asked to report their daily steps, as well as answer questions about how they accumulated their steps and the type of physical activities they participated in for the day aside from walking or running. This online log was designed to facilitate active self-monitoring. Additionally, general reminders about engaging with the different aspects of the walking program were posted on the homepage of each group's version of the Knoxville Moves website. Participants could also e-mail the primary investigator (C.M.) technical or clarification questions or concerns directly from the website. During the first three weeks of the study, the primary investigator (C.M.) analyzed participants' step counts on both the Omron Fitness website and the Knoxville Moves website and gave each participant general feedback messages, acknowledging whether or not the step goal was reached. Throughout the study, when participants did not upload or self-report their steps by the end of the week, the primary investigator (C.M.) sent them an e-mail reminder to do so.

In addition to the aforementioned features, the treatment group had a discussion board embedded in their Knoxville Moves website. Eight, small discussion board subgroups (three to

five participants per subgroup) were created with the intent of fostering a sense of connectedness with a few fellow participants and ultimately effective communication. The principal investigator (C.M.) placed participants in a subgroup as soon as they enrolled in the study and ensured that participants in a given subgroup started their walking program at the same time. During the first week of the program, they were asked to read an online handout on the Knoxville Moves website, which provided suggestions for discussion topics. They were also asked to make a post during the first week of the program in order to introduce themselves to their fellow subgroup members and subsequently enter the discussion board at least three times per week during the study period to read and type posts. Once participants introduced themselves to their subgroup members via the discussion board, they could also communicate with them via an instant message tool. They were asked to download this tool to their personal computer via a link from the Knoxville Moves website during the first week of the program and add their subgroup members to their list of contacts. The instant message feature allowed participants to communicate with each other via typed text if they happened to be online at the same time. It was designed to facilitate spontaneous, synchronous chats. Participants were given the opportunity to communicate with their subgroup members via one scheduled, synchronous live chat, as well. An online chat room launched from the Knoxville Moves website served as the venue for the scheduled live chats, allowing participants to communicate via typed text. The primary investigator (C.M.) moderated the scheduled live chats to initially prompt discussion, but did not provide social support. The researchers did not provide any input on the discussion board or through the instant message function.

Participants in both groups could access their respective Knoxville Moves website via a traditional computer (desktop or laptop) and on their smartphone via the mobile-friendly,

Blackboard Mobile Learn smartphone application. All of the features of the Knoxville Moves website were accessible via both options with the exception of the physical activity log, live chat function, and instant message function, which were only available via a computer.

Post-intervention Assessment

Participants repeated baseline measurements at the end of the 12 weeks (reported self-regulation for exercise, self-efficacy for exercise, social support for exercise, outcome expectations for exercise, weight, waist circumference, resting blood pressure, and body fat percentage). They also filled out an online satisfaction questionnaire (see Appendix N), which contained questions designed to gauge their thoughts about the helpfulness and usability of the overall program. Questionnaire items that were related to the discussion board and instant message features were only visible for the treatment group.

Measures

Average daily step counts

The steps each participant uploaded directly from her/his pedometer to the Omron Fitness website were used to calculate an average daily step count for each intervention week. In order to compute an average daily step count for each week, a minimum of three days/week of valid step count data were required.⁵⁴ Daily step counts were considered invalid if they were $< 100^{21}$ or participants reported on the Knoxville Moves online physical activity log that they did not wear their pedometer most of the day.

Self-regulation for exercise

The Exercise Goal-Setting scale (EGS) and The Exercise Planning and Scheduling scale (EPS) (see Appendix I)⁴⁸ served as measures of participants' self-regulation for exercise. The questionnaires are comprised of 10 items that participants rated on a 5-point scale ranging from 1

(does not describe) to 5 (describes completely). An average was computed for the item scores, eliciting a final score for each questionnaire. Higher scores represent a greater inclination to set exercise goals and make plans for exercise.

Self-efficacy for exercise

The Barriers Self-efficacy scale⁴⁹ (see Appendix G) was used to assess participants' self-efficacy for exercise. This 13-item questionnaire assesses participants' perceived capability to exercise for 40 minutes three times per week for the next three months when faced with obstacles to exercise participation. Participants provided a response to each item via an 11-point scale ranging from 0 (not at all confident) to 10 (highly confident). The item scores were averaged, yielding a final self-efficacy for exercise score. Higher scores reflect an enhanced perceived ability to exercise when confronted with barriers to exercise.

Social support for exercise

The 13-item Family and Friend Support for Exercise Habits scale⁵⁰ (see Appendix M) was used to assess participants' perceived social support for exercise from family and friends. It was also slightly adapted to assess participants' perceived social support from persons they connected with via online networks. Participants rated each item three times (once for perceived social support for exercise from family, once for perceived social support for exercise from friends, and once for perceived social support for exercise from persons they connected with via online networks) on a 5-point scale spanning from 1 (none) to 5 (very often). An average of the item scores was calculated to determine the final score for each questionnaire. Higher scores suggest a greater perceived sense of social support for exercise from friends and family. A "does not apply" option is available for each item. Participants who selected this option as a response to one or more items were removed from the analysis for the respective variable(s).

Outcome expectations for exercise

The Multidimensional Outcome Expectations for Exercise Scale⁵¹ (see Appendix H) was used to gauge participants' outcome expectations regarding the benefits of exercise. This 15-item questionnaire had three subscales (physical, social, and self-evaluative outcome expectations). Participants responded to each item using a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Item scores for each subscale were averaged, yielding a final score for each respective subscale. Higher scores indicate a stronger belief in the positive outcomes of exercise.

Physical characteristics

Participants wore light clothing without shoes and socks for their height and weight measurements, which were taken using a standard wall-mounted stadiometer and an electronic scale (Tanita Body Composition Analyzer, Model BC-418), respectively. Participants' weight (kg) was divided by height (m) squared to yield their BMI. Their waist circumference was measured at the narrowest part of the torso (above the umbilicus and below the xiphoid process)⁵⁵ using a Gulick spring-loaded tape measure. Two measurements were made, and the average of the two measurements was used as the final waist circumference value. A bioelectrical impedance analyzer (Tanita Body Composition Analyzer, Model BC-418) was used to assess participants' body fat percentage. Participants' blood pressure values were measured in their right arms with an aneroid sphygmomanometer (inflatable cuff and pressure gauge) and stethoscope. Participants sat in a chair for five minutes prior to the measurement. Two measurements were made one minute apart in order to ensure accuracy. The average of the two measurements served as the final blood pressure value.

Website access and smartphone application use

A time stamp was produced each time a participant logged in to the Knoxville Moves website regardless of whether it was through the smartphone application or a computer. These data were used to determine the dates and number of times each participant logged-in to the Knoxville Moves website.

One item on the online post-intervention questionnaire asked participants to report how often they used the Blackboard Mobile Learn smartphone application during the course of the intervention (“Never,” “Seldom,” “Sometimes,” “Usually,” and “Always” were the choices).

Discussion board, live chat, and instant message use

When participants in the online social support group submitted a new message or a reply on the discussion board, it was counted as a “post.” One item on the post-intervention online questionnaire also asked participants in this group to self-report how often they viewed posts by other participants. They chose one of the following choices: “Never,” “Less than one time per week,” “Weekly,” “Several times per week,” or “Daily.” Another item in the online post-intervention questionnaire asked participants in the online social support group to indicate whether or not they used the instant message function. The primary investigator (C.M.) counted the number of participants who participated in each scheduled live chat.

Data Analysis

SPSS version 21.0.0 for Windows (SPSS Inc., Chicago, IL) was used for the statistical analyses. Descriptive statistics were calculated for all baseline measures for all participants who originally enrolled in the study ($n = 63$), all participants who actually began the study ($n = 57$), and study completers ($n = 46$). Independent t -tests and X^2 analyses were used to measure baseline differences between study completers and non-completers for the entire sample ($N = 63$).

and for the sample excluding the six participants who never began the study ($N = 57$).

Independent t -tests and X^2 analyses were also conducted to measure baseline differences between the online social support group and the no online social support group for all three samples mentioned above. A mixed-factor ANOVA (with time point as the within-participant variable, and group as the between-participant variable) was conducted to examine changes in steps per day, self-regulation for exercise, self-efficacy for exercise, social support for exercise, outcome expectations for exercise, anthropometric variables, resting blood pressure, and body fat percentage. For significant interactions, pairwise comparisons, using Bonferroni corrections, were conducted at each time point to determine when the differences occurred. To calculate average daily steps, the issue of missing data was addressed. Missing step count data was handled in two ways for weeks in which an average daily baseline step count could not initially be calculated due to < 3 days of valid step count data. First, three study completers (two treatment and one control) and two dropouts (one treatment and one control) had available self-reported steps from the Knoxville Moves online physical activity log for days in which their uploaded steps were missing (53 days total). These self-reported steps were inserted in place of the missing uploaded steps because there was a significant, strong, positive correlation ($r = 0.99$, $p = 0.000$) between their self-reported steps and corresponding available uploaded steps (222 pairs of data points were examined using a Pearson correlation coefficient). Second, if self-reported steps were not available to be used as a substitute for missing uploaded steps, then a standard method within SPSS (expectation maximization or EM) was used to impute the missing average daily step count. Both an intention-to-treat analysis and a completers analysis were used to examine treatment comparisons for the change in daily steps. All participants who were randomized and began the study were included in the intention-to-treat analysis. To address

missing step counts for subjects who dropped out of the study, the last step count value for a participant was carried forward from the time of dropout until the end of the study. Only participants who completed the post-intervention assessment were included in the completers analysis.

For completers, descriptive statistics (means and standard deviations) were calculated for the percentage of the step goal that was achieved over the course of the study and number of days/week the step goal was met. The percentage of the step goal that was achieved was calculated by dividing the average daily step count for each week of the intervention (including weeks in which the average daily step count was based on self-reported step count data or estimated using the EM method) by the prescribed step goal for that respective week and multiplying the resulting quotient by 100. Only step count data for each valid week of the intervention (≥ 3 days/week of valid step count data) were considered when determining the number of days/week the step goal was met. A total of 3,640 days were part of valid intervention weeks (94% of all possible days in which step count data could have been uploaded and reported during the entire intervention). Thirty-two self-reported step counts (0.9% out of the total days considered) were inserted in place of a missing uploaded step count when determining the number of days/week the step goal was met. Out of the valid weeks, valid step count data were not available for 105 days due to a step count of < 100 or participants reporting that they did not wear their pedometer most of the day. These days (2.9% out of the total days considered) were counted as part of the valid weeks when analyzing the number of days/week the step goal was met.

Means and standard deviations were presented for continuous variables with a normal distribution. Percentages were presented for categorical variables. Pearson correlation

coefficients and Spearman correlation coefficients were computed to evaluate relationships among change in daily step counts (steps/day), change in psychosocial variables, website access variables, and discussion board use variables. Spearman correlation coefficients were used when one (or both variables) being correlated was non-normally distributed. Otherwise, Pearson correlation coefficients were used. The following variables were non-normally distributed: change in self-efficacy for exercise, log-ins per week, days logged-in per week, discussion board posts, and reported frequency of viewing the discussion board. The change in daily step counts variable was calculated by computing a mean daily step count across the 12-week study, utilizing the average daily step count for each week. The difference between this value and the average daily baseline step count reflected the change in daily steps. The change in each one of the psychosocial constructs was calculated using each respective variable's baseline and post-intervention scores.

Descriptive statistics were also calculated for measures of web access (means and standard deviations), smartphone application use (percentages), discussion board use (percentages, mean and standard deviation, median and interquartile range, and frequency counts), live chat use (frequency counts), instant message use (frequency counts) and satisfaction (percentages).

For all analyses, an alpha level of 0.05 was selected to indicate statistical significance.

Results

Recruitment

A total of 152 individuals initially expressed interest in the study. Sixty-three met all eligibility criteria and were enrolled in the study. Six of these 63 participants never began the study and were not included in the intention-to-treat analysis. These subjects did not upload or

report any step count data. The primary investigator (C.M.) attempted to contact them, but they were unresponsive; thus there were no step data for analysis on these individuals. An additional 11 participants (six online social support group and five no online social support group) began the intervention, but did not return for the post-intervention assessment. When considering the entire sample ($N = 63$), there were no significant differences for any of the demographic variables and physical characteristics between the participants who completed the study ($n = 46$) and the participants who did not complete the study ($n = 17$). When considering the sample without the six participants who were enrolled in the study, but did not begin it ($N = 57$), there were no significant differences for any of the demographic variables and physical characteristics between the participants who completed the study ($n = 46$) and the participants who did not complete the study ($n = 11$). The flow of participants through the study is presented in a CONSORT flow chart (Figure 2.1).

Baseline characteristics

Participants' ($N = 63$) ages ranged from 23 to 63 years (mean age = 48.2 ± 10.4 y). The sample was obese (mean BMI = 31.1 ± 5.7 kg·m⁻²). The majority of the participants were Caucasian, women, and college graduates (bachelor's or graduate degree) (Table 2.1). The characteristics of the sample without the six participants who were enrolled in the study, but did not begin it ($N = 57$), as well as the study completers ($N = 46$) were similar to those of the entire sample (Table 2.2 and Table 2.3). There were no significant differences between the treatment group and the control group for any of the demographic variables or physical characteristics (Table 2.1, Table 2.2, and Table 2.3).

Average daily step counts

There was no significant difference in average daily baseline step counts between the treatment and control groups, using the intention-to-treat analysis ($N = 57$) ($p > 0.05$).

Participants in both the treatment and control groups significantly increased their steps/day from baseline to 12 weeks ($p < 0.05$), but there were no significant differences between groups (Table 2.4). The magnitude of the increase was about 1500 and 2800 steps/day for the treatment and control groups, respectively (Figure 2.2)

There was no significant difference in average daily baseline step counts between the treatment and control groups, using the completers analysis ($N = 46$) ($p > 0.05$). Participants in both the treatment and control groups significantly increased their steps/day from baseline to 12 weeks ($p < 0.05$), but there were no significant differences between groups (Table 2.4). The magnitude of the increase in steps was about 1635 and just over 2900 for the treatment and control groups, respectively (Figure 2.3)

To document how closely participants adhered to the step prescription, weekly step averages were compared to weekly step goals. For the treatment group, weekly step averages were $91.0 \pm 26.5\%$ of the step goal. For participants in the control group, the weekly average was $104.3 \pm 23.2\%$ of the prescribed number of steps. The treatment group and the control group met their step goal an average of 3.4 ± 1.9 and 3.8 ± 1.9 days/week, respectively.

Secondary Outcomes

Results for all secondary outcomes (psychosocial variables and physical characteristics) are reported for completers in each group ($n = 23$ per group).

Social support for exercise

There were no significant differences between the treatment and control groups for the perceived social support variables ($p > 0.05$). Sample sizes varied for these measures due to the exclusion of participants from a given analysis if they selected the “does not apply option.”

There was not a significant group by time interaction, ($p > 0.05$) nor there were any significant main effects ($p > 0.05$) for perceived social support from friends and perceived social support from online networks. Both the treatment and control groups’ perceived social support from family significantly increased ($p < 0.05$), but there were no significant differences between groups (Table 2.5).

Self-efficacy for exercise

A significant decrease in self-efficacy for exercise was found for both the treatment ($n = 23$) and the control group ($n = 23$) ($p < 0.05$) (Table 2.5).

Self-regulation for exercise

A significant increase in exercise goal setting was found for the treatment group ($n = 23$) and the control group ($n = 23$), ($p < 0.05$) with no significant difference between groups. A significant group by time interaction was found for exercise planning ($p < 0.05$) such that the control group reported an increase in exercise planning, while the treatment group experienced no change (Table 2.5).

Outcome expectations for exercise

There was not a significant group by time interaction ($p > 0.05$) for any of the three outcome expectations for exercise subdomains (physical, social, and self-evaluative). There were also no significant main effects of time or group ($p > 0.05$) for any of the three subdomains ($n = 23$ per group) (Table 2.5).

Physical characteristics

Significant decreases in body fat percentage and systolic and diastolic blood pressure were observed for the treatment group ($n = 23$) and the control group ($n = 23$), ($p < 0.05$) with no significant differences between groups. There was not a significant group by time interaction, ($p > 0.05$), nor were there were any significant main effects ($p > 0.05$) for the other measured physical characteristics (Table 2.6).

Website access and smartphone application use

For study completers, the number of log-ins per participant per week to the Knoxville Moves website was 1.4 ± 0.9 for the treatment group ($n = 23$) and 1.7 ± 1.4 for the control group ($n = 23$). Treatment group participants logged-in to the Knoxville Moves website an average of 1.1 ± 0.75 days per week, and the control group participants logged-in to this website an average of 1.5 ± 1.2 days per week.

The percentage of the study completers in each group that reported never using or seldom using the smartphone application to access the Knoxville Moves website was high (82% and 87% for the treatment group and control group, respectively).

Discussion board, live chat, and instant message use

Of the study completers in the treatment group ($n = 23$), 65% made at least one discussion board post and 52% drafted multiple posts. The mean number of posts per participant was 3.3 ± 4.6 . Participants' median number of drafted posts was 2 (IQR: 0.0 to 5.0). All of the participants reported accessing the discussion board to read other participants' posts (7 of the 23 participants reported doing so less than one time per week, 13 reported doing so weekly, and 3 reported doing so several times per week).

The principal investigator (C.M.) attempted to schedule one live chat during the study for each one of the eight subgroups of participants. However, only two live chats were actually administered. Two participants from two separate subgroups engaged in each live chat. A live chat could not be scheduled at a time that worked for at least two or more of the participants in the other six subgroups.

Four of the 23 participants reported that they used the instant message function.

Correlation coefficients

Table 2.7 presents the Pearson correlations and Spearman correlations among change in daily step counts, change in psychosocial variables, website access, and discussion board use for study completers in the treatment group. Of note, significant, positive correlations were found between the change in daily steps and the following six variables: log-ins per week ($r_s = 0.60$; $p = 0.001$), number of days logged-in per week ($r_s = 0.61$; $p = 0.003$), discussion board posts ($r_s = 0.43$; $p = 0.043$), change in perceived social support from online networks ($r = 0.61$; $p = 0.008$), change in exercise goal setting ($r = 0.47$; $p = 0.026$), and change in exercise planning ($r = 0.45$; $p = 0.031$). Significant, positive correlations were also found between log-ins per week and the following four variables: change in self-efficacy for exercise ($r_s = 0.44$; $p = 0.035$), change in perceived social support from online networks ($r_s = 0.54$; $p = 0.020$), discussion board posts ($r_s = 0.74$; $p = 0.000$), and self-reported frequency of accessing the discussion board to view other participants' posts ($r_s = 0.56$; $p = 0.006$).

Table 2.8 provides the Pearson correlations and Spearman correlations among change in daily step counts, change in psychosocial variables, and website access for study completers in the control group. Of note, significant, positive correlations were found between the change in daily steps and the following two variables: log-ins per week ($r_s = 0.63$; $p = 0.001$) and number

of days logged-in per week ($r_s = 0.60$; $p = 0.003$). A significant, positive relationship was also found between log-ins per week and change in exercise self-efficacy ($r_s = 0.50$, $p = .015$).

Satisfaction

Participants in each group found their respective intervention to be highly acceptable. Based on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree), 96% of the participants in the treatment group agreed or strongly agreed that they were satisfied with the online walking program and would recommend it to a friend, co-worker, and/or family member. Eighty-three percent of the participants in the control group agreed or strongly agreed that they were satisfied with the online walking program, and 87% agreed or strongly agreed that they would recommend it to a friend, co-worker, and /or family member.

Discussion

The aim of this study was to evaluate the effect of providing access to online social support tools that make up one part of a theory-based, technology-mediated walking intervention on step counts among adults. Another aim was to investigate changes in presumed behavior change mediators. Granting access to online social support tools (discussion board, live chat, and instant message) did not result in an increase in daily steps beyond that provided by an identical technology-mediated walking intervention in which no online social support tools were provided. Both interventions resulted in similar, small, but significant improvements in family support and exercise goal setting. The control group also experienced an improvement in exercise planning; whereas, the treatment group's reported exercise planning did not change. Contrary to the intended effect, both groups' self-efficacy for exercise significantly declined.

The observed significant improvement in each group's average daily steps from baseline to the end of the intervention period (using intention-to-treat analysis, about 1500 for treatment

group participants and 2800 for control group participants) is consistent with findings from previous short-duration, pedometer-based studies that have used a similar step goal.^{19,56-58} It is also in line with findings from previous Internet-mediated, pedometer-based studies,^{19-21,59,60} including a pilot study²⁰ in which course-related Internet technology was used to deliver an eight-week walking intervention for university faculty and staff. In this previous study,²⁰ participants received the same step goal that was given in the present study, as well as access to an SCT-based website delivered through the Blackboard Learn platform. Participants significantly increased their average daily steps by about 1800 and found the intervention to be highly acceptable. Two other course-based Internet technology studies centered on physical activity promotion have found improvements in self-reported physical activity among college students.^{17,18} Unlike these studies, the present study used a free, publicly available course-based Internet technology platform (CourseSites) as a delivery medium for the intervention. The wide accessibility of this platform means that it could potentially be applied to a variety of populations and settings.

While both groups' average daily steps increased as a result of a CourseSites-delivered walking intervention, the fact that providing access to online social support tools did not result in an enhanced intervention effect may be due in large part to the low use of these features. Richardson et al.²¹ also conducted a randomized controlled physical activity promotion trial, isolating the impact of an online community on participants' step counts. Similar to the current study, Richardson et al.²¹ found a significant increase in step counts for both the treatment and control groups, with no difference between groups. It appears that the low use of this technology when participants are randomly assigned to groups is a factor that future researchers should acknowledge.

Only four of the 23 treatment group participants in the present study engaged in a scheduled live chat. In a Blackboard Learn pilot study,²⁰ an identical live chat function was only used by five of the 36 participants. Scheduling live chats at times that participants are willing to participate is a major barrier. In the present study, it was difficult to find a time when at least two or more participants in a given subgroup could participate in a live chat. For this reason, the live chat feature, when coordinated by the site administrator, does not appear to be an effective tool for maximizing participant engagement.

Participants were also given access to an instant message tool, giving them a chance to initiate their own live chats. However, 83% of the participants reported that they did not use this tool. Participants had access to an asynchronous form of communication (discussion board), as well. Yet, they submitted a mean of just over three posts during the course of the study. This low level of engagement with the discussion board contrasts with findings from the previously mentioned Blackboard Learn study²⁰ in which participants drafted a mean of just over eight posts. However, it is in line with the findings of two reviews of literature^{45,61} concentrated on the effects of health-related online communities on various health outcomes. The lack of use of the online communities in this and previous studies leaves uncertainty on the impact of this technology on health outcomes.

The approach used in the present study was designed to maximize participant engagement. That is, participants were provided with two ways to access the discussion board (computer and smartphone application). They also had access to multiple online social support tools. In addition, online community subgroups were created in an attempt to foster a sense of closeness among a small group of participants, and in turn, stimulate communication. Yet, this approach was not effective at optimizing the overall use of the online social support features.

Participants in the treatment group, for the most part, did not take the opportunity to connect with each other. Thus, just offering access to online social support tools may not be enough to stimulate use. Given the lack of data on the use of online social support networks, it is unknown what the optimal size of a support group should be. More research is needed to determine the size of a group needed to generate a vibrant and robust discussion board conversation. Perhaps providing participants with more training focused on the use of the social support tools and the ways in which they can be beneficial would have been a helpful strategy for facilitating use. It may be important to facilitate communication early after a group's formation to ensure that members engage with one another. It is possible that in the present study the lack of participation by some subjects may have been discouraging to participants who were interested in using the discussion board and subsequently prompted them to discontinue their use of it. For example, two participants who were part of a subgroup of three participants never made a post. The third participant in this group made two posts before typing a third post in which she asked, "Who are my contacts?" She never made another post and actually stated on the post-intervention satisfaction questionnaire that she was disappointed that there was no online discussion with her subgroup members. The use of small subgroups may have also magnified the live chat scheduling difficulties and partially explained why most of the participants did not use the instant message feature.

Kosma et al.⁶² attempted to examine the isolated impact of a discussion board as one part of an Internet-mediated intervention on physical activity levels of adults with disabilities. They randomized participants to one of three groups (one Internet-mediated group that received access to a discussion board, one Internet-mediated group that did not receive access to a discussion board, and an attention control group). They assigned their treatment group participants to small

discussion board subgroups (about seven people per subgroup). However, only six messages were exchanged during the one-month intervention, so the authors combined the two treatment groups into one group for the analyses. Likewise, Turner-McGrievy et al.⁶³ conducted a six-month weight loss study in which they employed a similar approach in an effort to facilitate communication among intervention participants. These participants had access to Twitter (an online social media network) as part of their intervention and were assigned to a small cohort of 10 to 11 people. They were encouraged to use Twitter to communicate with and provide support for their fellow group members much like in the present study. However, the level of participation was so sporadic that the authors allowed the participants to communicate with everyone in their intervention group (not just their cohort) for the last three months of the study. The authors found that their participants' physical activity increased from baseline to the end of the intervention, but the improvement was not statistically significant.

Despite the low level of overall participant engagement with the online social support tools, a borderline significant, positive correlation ($r_s = 0.47$, $p = 0.05$) was observed between discussion board posts and the change in online social support. In addition, significant, positive relationships were found between the change in daily steps and discussion board posts ($r_s = 0.43$; $p = 0.043$), as well as the change in online social support ($r = 0.61$; $p = 0.008$) for the treatment group participants. A favorable relationship between discussion board posts and change in daily steps was also observed among the intervention groups of two other studies that employed an Internet-mediated walking intervention.^{20,21} It is possible that participants in the present study who were highly motivated at the onset of the intervention to increase their physical activity also happened to post more messages on the discussion board. On the other hand, such findings may collectively indicate that the discussion board is an effective online social support tool for

participants who are motivated to take advantage of it. It may be wise to screen for this inclination when enrolling individuals in subsequent studies. It remains unknown how to make interactive technology attractive to a larger proportion of study participants.

Significant, positive relationships were observed between the number of log-ins per week and both discussion board posts ($r_s = 0.74$; $p = 0.000$) and self-reported viewing of discussion board posts ($r_s = 0.56$; $p = 0.006$). The aforementioned Blackboard Learn study²⁰ also observed a significant relationship between log-ins per week and self-reported viewing of discussion board posts, suggesting that the discussion board may be an effective tool for facilitating increased intervention engagement. Increasing participants' engagement in a website has been linked to positive outcomes in health behavior change research.^{20,64-67} While the significant, favorable relationship between the number of log-ins per week and change in steps per day among both the treatment group and the control group may indicate that those participants who were highly motivated to improve their physical activity also happened to log-in to the website frequently, it may also support the notion that increased website engagement results in positive outcomes.

The significant, positive relationship between the number of log-ins per week and the change in exercise self-efficacy among the treatment group and the control group may also bolster this latter notion. Despite this relationship, an overall decline in exercise self-efficacy was found among each study group. Previous physical activity promotion research in which a decline in exercise self-efficacy was observed has suggested that participants may recalibrate their expectations based upon information and experiences they gain from participating in the intervention, and this factor may partially explain the unintended effect of the intervention on exercise self-efficacy.^{24,68} Participants did not experience improvements in outcome expectations, which is similar to previous research.^{20,22,24,69} Outcome expectation levels were

relatively high at baseline for each group, which may have limited the ability to improve this variable.

However, both groups' reported goal setting increased, and the control group experienced a significant improvement in exercise planning. It is unclear why the control group reported an improvement in making plans for exercise, but the treatment group's reported exercise planning did not change. Nevertheless, the greater use of self-regulatory behaviors among study participants may have been attributed to the use of a step goal, pedometer, and online self-monitoring tools (Omron Fitness website and Knoxville Moves physical activity log). A review of literature on pedometer-based studies detailed the importance of these factors for increasing physical activity.⁷⁰ These improvements in self-regulation are important because it is an integral SCT concept⁷¹ that has been associated with improvements in physical activity in previous studies.^{18,24,37,69,70} In fact, both exercise goal setting and exercise planning were significantly and positively associated with the change in daily steps in the treatment group in the present study.

The combined use of a pedometer and the Omron Fitness website as a self-monitoring method was one of the strengths of this study as it allowed for an objective measurement of physical activity and much like CourseSites, the Omron Fitness website is a publicly available platform that could potentially be applied to a variety of populations and settings. Yet, one possible downside of using the Omron Fitness website in conjunction with another website is that it may impact engagement with the other website. For instance, participants in a pilot Blackboard Learn study²⁰ logged-in to the intervention website an average of three times per week; whereas, both the treatment group and control group participants in the present study logged-in to the website an average of just over one time per week. The participants in the Blackboard Learn study only had one option for tracking their steps (an online physical activity

log, which was accessed via the intervention website). In the present study, participants did not have to use the online physical activity log on the Knoxville Moves website to track their steps (even though they were encouraged to do so), and this may partly explain the overall lower level of engagement with the Knoxville Moves website.

Another strength of this study was the employment of a smartphone application that gave participants an additional way to access the Knoxville Moves website. Interestingly, the majority of the participants did not use the smartphone application. It is unknown if the availability of a self-monitoring feature (physical activity log) via the smartphone application would have affected use. Smartphone application-based physical activity promotion research is still emerging, so this information is particularly useful. Future research is needed to determine how to best utilize smartphone applications for physical activity promotion.

The use of a pedometer-based, Internet- and smartphone-mediated physical activity intervention not only resulted in improvements in physical activity and some potential psychosocial mediators, but it also resulted in improvements in body fat percentage and blood pressure in both the treatment group and the control group. These improvements further support the established link between improvements in walking and improvements in health-related outcomes.¹ Other pedometer-based interventions have also reported improvements in these two variables with increased activity.⁷²⁻⁷⁵

Although a number of positive outcomes were found, future research is still needed to determine how to prompt the increased use of online social support tools.⁴⁵ In their review of literature on this topic, Maher et al.⁴⁵ suggested that online communities that build upon existing ties, as opposed to trying to connect persons with strangers, is an approach that is worthy of future exploration. They also suggested that future research should test innovative approaches

(e.g., gamification) for stimulating engagement. It is possible that only a certain group of users actually benefits from the use of online social support tools. Identifying the characteristics of those users is a valuable focus for future research.

All of the findings from this study must be considered in light of its limitations. It was characterized by a small, relatively homogeneous sample of adults and a short intervention length. Whether or not the type of intervention used in this study would result in sustained changes in activity is a topic for further exploration. Technical issues were also experienced during the course of the study, which may have impacted the findings. In particular, most of the study participants could not log-in to the Omron Fitness website for several days and noted on the post-intervention satisfaction questionnaire that this issue frustrated them. Technical difficulties notwithstanding, the participants found their respective interventions to be highly acceptable and useful.

Conclusions

The findings from this randomized controlled trial of adults suggest that the added feature of online social support tools to a course-based, Internet- and smartphone application-mediated intervention rooted in the SCT does not provide a superior effect on increases in daily steps and social support relative to an identical intervention without these tools. These tools still may be effective for certain users, but ascertaining how to maximize the use of them remains a challenge.

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APPENDIX

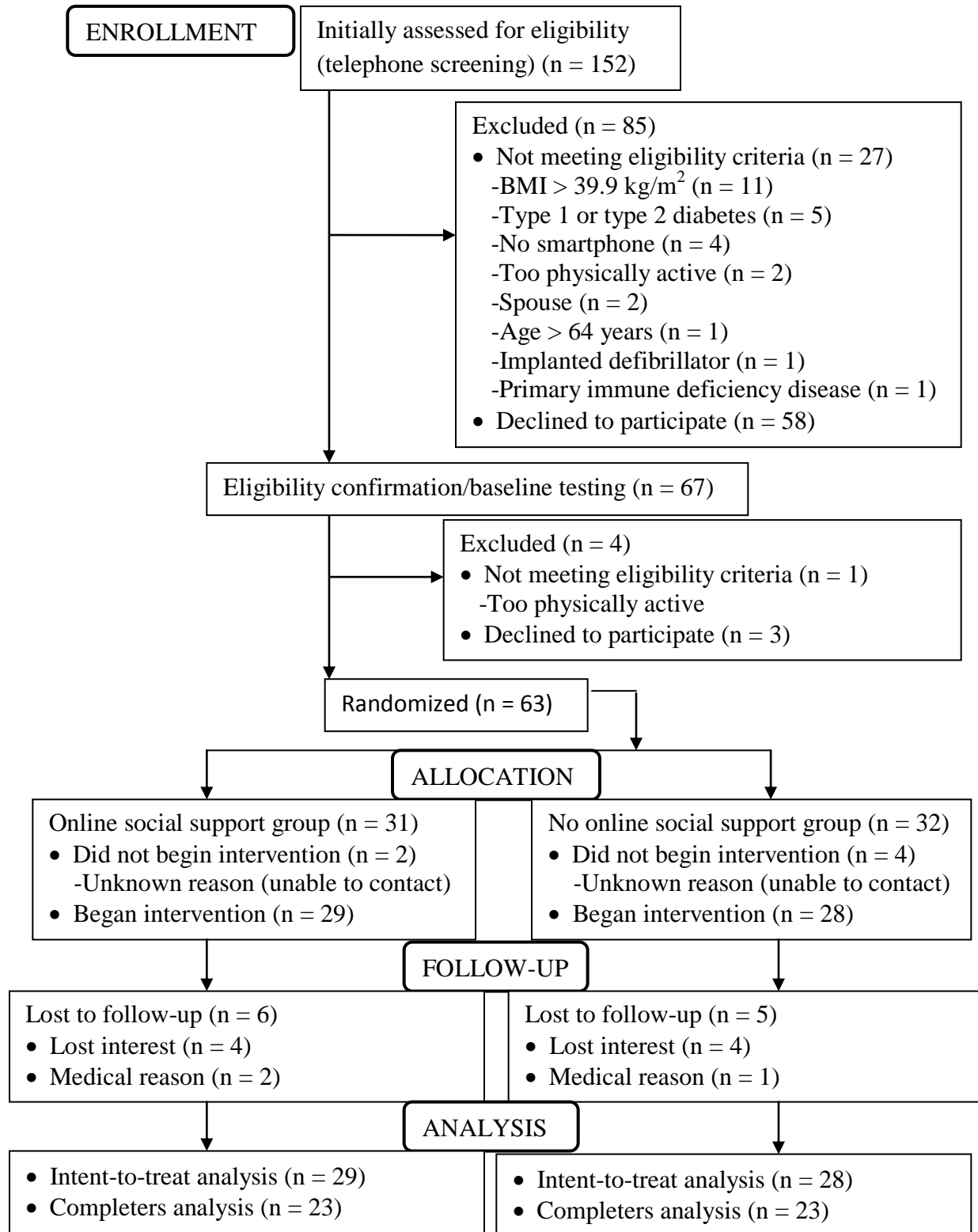


Figure 2.1. Recruitment flow sheet.

Table 2.1. Baseline demographics and physical characteristics of participants who enrolled in the study

| Measure | Total (N = 63) | Online social support group (N = 31) | No online social support group (N = 32) |
|--|-------------------|---|--|
| Age, y | 48.2 (10.4) | 48.0 (10.7) | 48.3 (10.3) |
| Sex | | | |
| Female | 88.9% | 87.1% | 90.6% |
| Male | 11.1% | 12.9% | 9.4% |
| Race | | | |
| Caucasian | 79.4% | 80.6% | 78.1% |
| African-American | 17.5% | 16.1% | 18.8% |
| Multiracial | 1.6% | 3.2% | 0.0% |
| Other | 1.6% | 0.0% | 3.1% |
| Education | | | |
| High school diploma or GED | 12.7% | 12.9% | 12.5% |
| Some college | 20.6% | 22.6% | 18.8% |
| Bachelor's degree | 33.3% | 25.8% | 40.6% |
| Graduate degree | 33.3% | 38.7% | 28.1% |
| Height, cm | 166.6 (8.6) | 167.1 (9.2) | 166.0 (8.1) |
| Body mass, kg | 86.8 (20.2) | 89.0 (20.5) | 84.7 (20.0) |
| Body mass index, $\text{kg} \cdot \text{m}^{-2}$ | 31.1 (5.7) | 31.6 (5.5) | 30.5 (5.9) |
| Waist circumference, cm | 95.8 (15.6) | 97.6 (15.2) | 93.9 (15.9) |
| Body fat percentage | 39.4 (7.8) | 40.3 (7.4) | 38.6 (8.1) |
| Resting SBP, mmHg | 124.8 (10.5) | 125.7 (9.9) | 123.8 (11.2) |
| Resting DBP, mmHg | 76.8 (8.8) | 77.2 (9.0) | 76.3 (8.8) |

Note. Values are means and standard deviations unless indicated by percentage (%); N = number of participants; GED = general equivalency degree; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; Data are mean (SD) unless otherwise noted. There were no significant group differences.

Table 2.2. Baseline demographics and physical characteristics of participants who began the study

| Measure | Total (N = 57) | Online social support group (N = 29) | No online social support group (N = 28) |
|--|-------------------|---|--|
| Age, y | 48.2 (10.9) | 48.0 (11.0) | 48.5 (11.0) |
| Sex | | | |
| Female | 89.5% | 89.7% | 89.3% |
| Male | 10.5 % | 10.3% | 10.7% |
| Race | | | |
| Caucasian | 80.7% | 79.3% | 82.1% |
| African-American | 15.8% | 17.2% | 14.3% |
| Multiracial | 1.8% | 3.4% | 0.0% |
| Other | 1.8% | 0.0% | 3.6% |
| Education | | | |
| High school diploma or GED | 14.0% | 13.8% | 14.3% |
| Some college | 22.8% | 24.1% | 21.4% |
| Bachelor's degree | 28.1% | 24.1% | 32.1% |
| Graduate degree | 35.1% | 37.9% | 32.1% |
| Height, cm | 166.6 (8.5) | 166.5 (8.9) | 166.7 (8.2) |
| Body mass, kg | 87.0 (19.9) | 87.1 (19.8) | 86.8 (20.4) |
| Body mass index, $\text{kg} \cdot \text{m}^{-2}$ | 31.1 (5.7) | 31.2 (5.4) | 31.0 (6.0) |
| Waist circumference, cm | 95.9 (14.7) | 95.8 (13.6) | 96.0 (15.9) |
| Body fat percentage | 39.6 (7.7) | 40.2 (7.4) | 39.0 (8.1) |
| Resting SBP, mmHg | 125.3 (10.4) | 125.6 (9.6) | 125.0 (11.3) |
| Resting DBP, mmHg | 76.8 (9.1) | 77.1 (9.3) | 76.5 (9.1) |

Note. Values are means and standard deviations unless indicated by percentage (%); N = number of participants; GED = general equivalency degree; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; Data are mean (SD) unless otherwise noted. There were no significant group differences.

Table 2.3. Baseline demographics and physical characteristics of study completers

| Measure | Total (N = 46) | Online social support group (N = 23) | No online social support group (N = 23) |
|--|-------------------|---|--|
| Age, y | 47.0 (10.7) | 47.1 (10.3) | 47.0 (11.3) |
| Sex | | | |
| Female | 87.0% | 87.0% | 87.0% |
| Male | 13.0% | 13.0% | 13.0% |
| Race | | | |
| Caucasian | 76.1% | 73.9% | 78.3% |
| African-American | 19.6% | 21.7% | 17.4% |
| Multiracial | 2.2% | 4.3% | 0.0% |
| Other | 2.2% | 0.0% | 4.3% |
| Education | | | |
| High school diploma or GED | 10.9% | 13.0% | 8.7% |
| Some college | 19.6% | 21.7% | 17.4% |
| Bachelor's degree | 28.3% | 21.7% | 34.8% |
| Graduate degree | 41.3% | 43.5% | 39.1% |
| Height, cm | 167.4 (9.1) | 167.6 (9.5) | 167.2 (8.8) |
| Body mass, kg | 87.9 (20.6) | 88.6 (21.3) | 87.3 (20.5) |
| Body mass index, $\text{kg} \cdot \text{m}^{-2}$ | 31.1 (5.7) | 31.3 (5.7) | 31.0 (5.8) |
| Waist circumference, cm | 95.8 (14.9) | 95.6 (14.8) | 95.9 (15.3) |
| Body fat percentage | 39.0 (7.8) | 39.5 (7.9) | 38.6 (7.8) |
| Resting SBP, mmHg | 126.3 (10.4) | 126.3 (10.4) | 126.2 (11.2) |
| Resting DBP, mmHg | 78.1 (9.1) | 78.7 (9.1) | 77.4 (9.2) |

Note. Values are means and standard deviations unless indicated by percentage (%); ; N = number of participants; GED = general equivalency degree; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; Data are mean (SD) unless otherwise noted. There were no significant group differences.

Table 2.4. Average Omron-determined steps per day measured at baseline and 12 weeks

| | Online Social Support | No Online Social Support |
|--|-----------------------|--------------------------|
| Total steps (steps/day), intention-to-treat | | |
| | N = 29 | N = 28 |
| Baseline | 4461.5 (1480.7) | 4630.6 (1127.8) |
| 12 weeks | 5959.5 (1811.4)* | 7443.0 (2576.8)* |
| Total steps (steps/day), completers | | |
| | N = 23 | N = 23 |
| Baseline | 4584.6 (1495.2) | 4498.2 (1128.0) |
| 12 weeks | 6219.7 (1696.1)* | 7424.6 (2764.2)* |

Note. Data are mean (standard deviation); n = number of participants; *statistically significant difference from baseline at $p < 0.05$.

Table 2.5. Psychosocial variables for study completers

| Measure | N | Group | Baseline | 12 weeks |
|------------------------|----|--------------------------|-----------|-------------|
| Family social support | 22 | Online social support | 2.3 (0.8) | 2.7 (1.0)* |
| | 21 | No online social support | 2.3 (0.7) | 2.5 (0.5)* |
| Friends social support | 22 | Online social support | 2.2 (0.5) | 2.5 (0.8) |
| | 23 | No online social support | 2.1 (0.4) | 2.2 (0.5) |
| Online social support | 18 | Online social support | 1.7 (0.4) | 1.9 (0.3) |
| | 17 | No online social support | 1.9 (0.2) | 1.7 (0.3) |
| Exercise self-efficacy | 23 | Online social support | 7.0 (2.2) | 5.9 (2.0)* |
| | 23 | No online social support | 7.1 (2.3) | 6.5 (2.3)* |
| Outcome expectations | | | | |
| Physical | 23 | Online social support | 4.8 (0.3) | 4.8 (0.2) |
| | 23 | No online social support | 4.8 (0.3) | 4.7 (0.4) |
| Social | 23 | Online social support | 3.0 (1.0) | 3.1 (1.1) |
| | 23 | No online social support | 3.1 (0.9) | 3.2 (1.1) |
| Self-evaluative | 23 | Online social support | 4.7 (0.4) | 4.8 (0.4) |
| | 23 | No online social support | 4.6 (0.4) | 4.5 (0.5) |
| Self-regulation | | | | |
| Exercise goal setting | 23 | Online social support | 2.3 (0.9) | 2.5 (0.8)* |
| | 23 | No online social support | 2.3 (0.8) | 2.7 (0.8)* |
| Exercise planning | 23 | Online social support | 2.4 (0.7) | 2.3 (0.5) |
| | 23 | No online social support | 2.2 (0.5) | 2.6 (0.6)** |

Note. Data are mean (standard deviation); N = number of participants; Family and friends social support possible score range 1 (none) to 5 (very often); Exercise self-efficacy possible score range 0 (not confident at all) to 10 (highly confident); Outcome expectations possible score range 1 (strongly disagree) to 5 (strongly agree); Self-regulation possible score range 1 (does not describe) to 5 (describes completely); *statistically significant difference from baseline at $p < 0.05$; **statistically significant difference from the online social support group at $p < 0.05$.

Table 2.6. Change in physical characteristics of study completers for online social support group (n = 23) and no online social support group (n = 23)

| Measure | Group | Baseline | 12 Weeks |
|---------------------------------------|--------------------------|--------------|---------------|
| Body mass, kg | Online social support | 88.6 (21.3) | 89.0 (21.0) |
| | No online social support | 87.3 (20.5) | 87.3 (21.4) |
| Body mass index, kg · m ⁻² | Online social support | 31.3 (5.7) | 31.3 (5.6) |
| | No online social support | 31.0 (5.8) | 31.3 (6.3) |
| Waist circumference, cm | Online social support | 95.6 (14.8) | 96.3 (14.7) |
| | No online social support | 95.9 (15.3) | 95.1 (16.0) |
| Body fat percentage | Online social support | 39.5 (7.9) | 38.7 (8.1)* |
| | No online social support | 38.6 (7.8) | 37.1 (8.7)* |
| Resting SBP, mmHg | Online social support | 126.4 (9.7) | 121.6 (10.0)* |
| | No online social support | 126.2 (11.2) | 121.6 (10.5)* |
| Resting DBP, mmHg | Online social support | 78.7 (9.1) | 76.1 (5.3)* |
| | No online social support | 77.4 (9.2) | 73.3 (9.1)* |

Note. Data are mean (standard deviation); N = number of participants; SBP = systolic blood pressure; DBP = diastolic blood pressure; *statistically significant difference from baseline at p < 0.05.

Table 2.7. Pearson and Spearman correlation coefficients among change in daily step counts, change in psychosocial variables, website access, and discussion board use among study completers in the online social support group^

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---------------------------|-------|-----|-----|------|-------|------|------|-------|------|-----|-------|-------|-------|----|
| 1. Daily steps | - | | | | | | | | | | | | | |
| 2. Family social support | .01 | - | | | | | | | | | | | | |
| 3. Friends social support | .24 | .36 | - | | | | | | | | | | | |
| 4. Online social support | .61** | .43 | .11 | - | | | | | | | | | | |
| 5. Exercise goal setting | .47* | .38 | .42 | .28 | - | | | | | | | | | |
| 6. Exercise planning | .45* | .19 | .35 | .45 | .64** | - | | | | | | | | |
| 7. Exercise self-efficacy | .11 | .10 | .18 | .22 | .31 | .25 | - | | | | | | | |
| 8. Physical OE | -.12 | .06 | .05 | .24 | -.10 | .03 | -.29 | - | | | | | | |
| 9. Social OE | -.10 | .39 | .04 | .09 | .24 | .16 | -.05 | .19 | - | | | | | |
| 10. Self-evaluative OE | .08 | .31 | .20 | .22 | .21 | .40 | .21 | .64** | .42* | - | | | | |
| 11. Log-ins/wk | .60** | .10 | .15 | .54* | .18 | .12 | .44* | -.23 | -.12 | .03 | - | | | |
| 12. Days logged-in/wk | .61** | .01 | .06 | .51* | .10 | .11 | .38 | -.21 | -.05 | .02 | .98** | - | | |
| 13. DB posts | .43* | .33 | .09 | .47 | .20 | .00 | .38 | -.12 | -.10 | .01 | .75** | .71** | - | |
| 14. DB views | .23 | .41 | .16 | .27 | .19 | -.13 | .33 | -.15 | .11 | .07 | .56** | .50* | .75** | - |

Note. Italicized coefficients are Spearman coefficients and all other coefficients are Pearson coefficients; OE = outcome expectations; DB = discussion board; ^Sample size ranges from 18 to 23 among correlations due to selecting the “does not apply” option on The Family and Friend Support for Exercise Habits scale; *statistically significant at $p < 0.05$; **statistically significant at $p < 0.01$.

Table 2.8. Pearson and Spearman correlation coefficients among change in daily step counts, change in psychosocial variables, and website access among study completers in the no online social support group ^

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------------------|-------|------|------|------|-------|------|------|-------|-----|------|-------|----|
| 1. Daily steps | - | | | | | | | | | | | |
| 2. Family social support | .18 | - | | | | | | | | | | |
| 3. Friends social support | .18 | .43* | - | | | | | | | | | |
| 4. Online social support | .15 | .15 | .63* | - | | | | | | | | |
| 5. Exercise goal setting | .30 | .43 | .31 | .24 | - | | | | | | | |
| 6. Exercise planning | .28 | .45* | .16 | -.04 | .77** | - | | | | | | |
| 7. Exercise self-efficacy | .24 | .54* | .17 | .16 | .55** | .50* | - | | | | | |
| 8. Physical OE | -.25 | -.08 | .14 | -.24 | .07 | .11 | -.01 | - | | | | |
| 9. Social OE | -.08 | -.13 | -.04 | .17 | .24 | .07 | .18 | .36 | - | | | |
| 10. Self-evaluative OE | -.06 | -.34 | -.01 | -.34 | .20 | .08 | .20 | .74** | .38 | - | | |
| 11. Log-ins/wk | .63** | -.23 | .35 | .45 | .33 | .06 | .50* | -.25 | .35 | -.07 | - | |
| 12. Days logged-in/wk | .59** | .24 | .36 | .44 | .27 | .06 | .53* | -.20 | .28 | -.08 | .97** | - |

Note. Italicized coefficients are Spearman coefficients and all other coefficients are Pearson coefficients; OE = outcome expectations; ^Sample size ranges from 17 to 23 among correlations due to selecting the “does not apply” option on The Family and Friend Support for Exercise Habits scale; *statistically significant at $p < 0.05$; **statistically significant at $p < 0.01$.

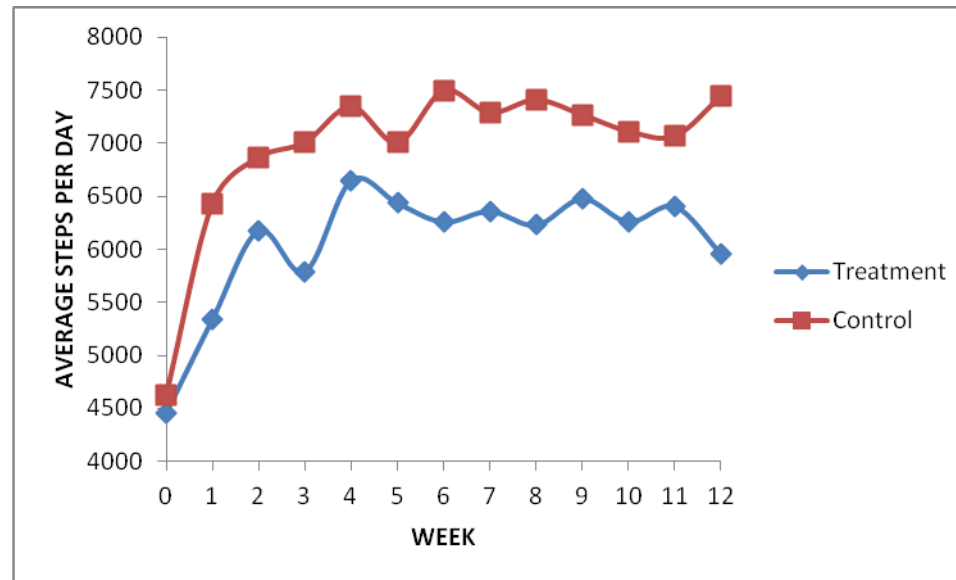


Figure 2.2. Changes in average Omron-determined steps per day according to intervention groups based on the intent-to-treat analysis (N = 57).

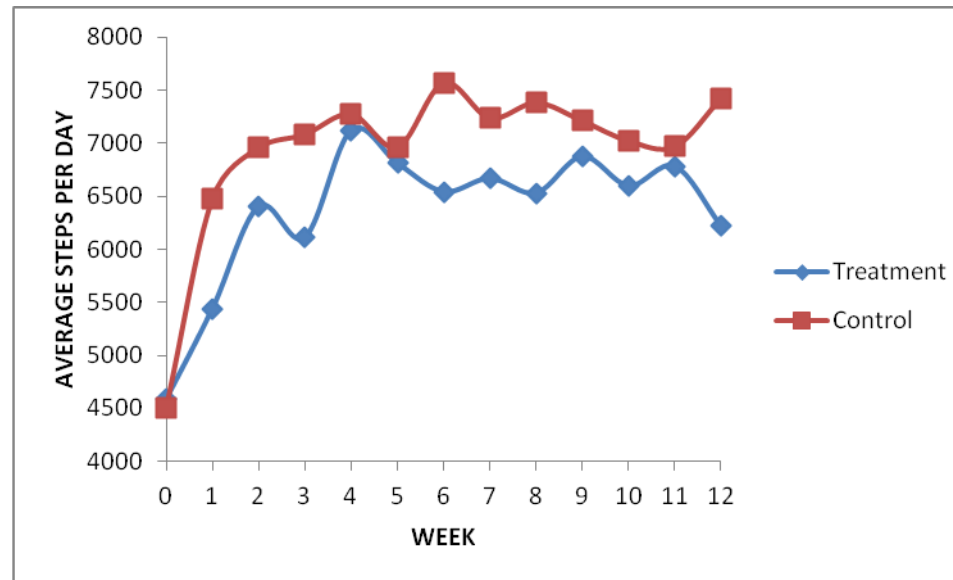


Figure 2.3. Changes in average Omron-determined steps per day according to intervention groups based on completers analysis (N = 46).

Part V
Conclusion

While a number of technologies can be used in physical activity promotion efforts, figuring out the best way to utilize them is an active research area. Online social support tools (e.g., discussion board, chat room, and instant message) represent one specific technological feature that can be accessed via the Internet and/or smartphone applications. They are designed to foster real-time or asynchronous communication among individuals. In the context of a physical activity intervention, they provide individuals with the opportunity to share their challenges and accomplishments, provide encouragement, and give supportive suggestions. Modest evidence exists regarding the effectiveness of interventions that have relied either wholly or in part on such tools for positively influencing health outcomes.¹

For example, findings from a Blackboard Internet-technology pilot walking intervention² that was comprised of a number of SCT-based components, including a discussion board, point to the potential effectiveness of such tools for favorably impacting physical activity levels among sedentary/insufficiently active university faculty and staff. That is, the sample in this intervention significantly improved their daily steps, self-reported physical activity, self-regulation, and social support. What is more, the discussion board was relatively active and a significant, positive correlation was found between the change in daily steps and discussion board posts.

The collective findings from this previously described pilot study helped inform the design of the present randomized controlled trial, which aimed to isolate the effect of providing access to online social support tools on adults' step counts, self-efficacy, self-regulation, social support, and outcome expectations. This trial also utilized a course management Internet platform (CourseSites) as the delivery medium for a 12-week, SCT-based walking intervention, and this intervention was accessible via a computer and smartphone application. Based on the

findings from this current study, granting access to online social support tools during the course of a technology-mediated walking intervention does not result in enhanced step counts and changes in psychosocial constructs relative to an identical intervention without these tools. However, all of the online social support tools were characterized by low use perhaps in part due to the utilization of small online walking subgroups in which the treatment group participants were asked to communicate with only two to four fellow participants, making it difficult to make definitive conclusions regarding the effectiveness of such tools. Participants who used the discussion board more often to draft posts did experience a greater increase in daily steps relative to participants who did not make as many posts. While it is possible that participants who were highly motivated to become more active also happened to draft more discussion board posts, it is also possible that the discussion board facilitated improvements in activity. Thus, such tools may be effective for certain users.

Future research in which different approaches are used to stimulate engagement in online communities (e.g., recruiting individuals who know each other or creating a game-like atmosphere) should be conducted. Additionally, identifying the characteristics of users who may benefit from online social support tools is also a valuable topic for future research.

References

1. Maher CA, Lewis LK, Ferrar K, Marshall S, De Bourdeaudhuij I, Vandelanotte C. Are health behavior change interventions that use online social networks effective? A systematic review. *Journal of Medical Internet Research*. 2014;16(2):e40.
2. Monroe CM, Thompson DL. UT Moves: Use of Blackboard Learn™ Internet-technology to promote walking among university faculty and staff. Unpublished data.

Appendices

Appendix A

Part III

Informed Consent Form, Recruitment Flyer, E-mail, and Electronic Announcement

INFORMED CONSENT FORM

UT Moves: Use of Blackboard Internet technology to promote walking among university faculty and staff

Principal Investigator: Courtney Monroe

Address: Department of Kinesiology, Recreation, and Sport Studies

College of Education, Health, and Human Sciences

The University of Tennessee

1914 Andy Holt Avenue

303 HPER Bldg.

Knoxville, TN 37996-2700

Phone: (865) 974-6040

E-mail: cmonroe9@utk.edu

STUDY PURPOSE

You are invited to take part in a research study entitled “UT Moves: Use of Blackboard Internet technology to promote walking among university faculty and staff.” The goal of this study is to examine the usefulness of an Internet-based program for promoting walking among university faculty and staff. If you give your consent, you will attend a testing session in the Applied Exercise Physiology Laboratory in the Health, Physical Education, and Recreation Building (room 318) on the University of Tennessee campus that will last approximately 75 minutes. You will not eat or drink within four hours of the tests. You will not perform any exercise within 12 hours of the tests. You will need to bring (or wear) shorts and a t-shirt to this testing session.

TESTING PROTOCOL

1. You will initially complete four questionnaires (general information, health history, physical activity readiness, and physical activity level).
2. Your resting blood pressure will be measured in your right arm using a blood pressure cuff like you may have experienced in a doctor’s office. You will sit in a chair for five minutes prior to the measurement. Two measurements will be made at least one minute apart in order to ensure accuracy.
3. Your height, weight, and body fat percentage will be measured. For these measurements you will be asked to remove your shoes and socks. We will measure your body fat percentage, using the bioelectrical impedance analysis (B.I.A.) technique. The machine we use looks like standard bathroom scales with handles added. This measurement involves a low-level electrical current that is used to determine how much lean tissue and fat tissue is in your body. This procedure takes less than a minute and just requires you to stand on the scale while holding onto the handles.

The information from these tests will be used in part to confirm your eligibility for this study. If you do not meet the eligibility criteria, then the testing process will end, and you will not be able to participate in the study. You will be given the collected health information.

4. The distance around your waist will be measured with a tape measure. Two measurements will be made in order to ensure accuracy.

5. You will complete four additional questionnaires. The questions are related to your thoughts and experiences related to exercise.

6. Finally, we will ask you to walk in the hallway at a normal pace for about 20 feet. We use that test to see how far you move with each step – your stride length. That information will be entered into a pedometer so we can estimate how far you walk each day. You will be given a pedometer to use during the study.

After this testing, we will ask you to wear a pedometer for one week while going about your normal routine. During this week, we ask that you place the pedometer in your front pocket or on your belt or waistband. You will wear it during all waking hours (except when swimming or showering). You should not change your usual activity patterns during this one-week time period. During this week, a piece of tape will be placed over the pedometer display to prevent you from seeing the step counts. At the end of this week, you will return to the laboratory so we can collect information from your pedometer. We will use this information to confirm your eligibility for the study in terms of habitual physical activity level (sedentary/insufficiently active). If you do not meet the eligibility criteria, then the testing process will end, and you will not be able to participate in the study. You will be given the collected health information. If you do meet the eligibility criteria, you will be shown how to use the physical activity-related website. This second visit will last about 60 minutes.

BLACKBOARD LEARN AND EXERCISE TRAINING

If you complete all testing, the one-week walking period, and you meet all eligibility requirements, you will be granted access to the physical activity-related website. You will access the website through Blackboard Learn. This is on the University of Tennessee website and will require the use of your UTK username and password. You are asked to view a tutorial the first time you access it. This tutorial will show you how to use the website. You will also wear the pedometer everyday during waking hours (except when swimming or showering) throughout the eight-week study.

You will receive a minimum physical activity recommendation that will use a daily step goal. You will be encouraged to walk at least 3,000 steps above your average daily baseline step count on at least 5 days each week for eight weeks. You will be encouraged to gradually increase the number of steps you take until you reach this goal. You will use the website to log your daily physical activity, including your steps per day.

The study website will have a section where you can access weekly lessons, which will consist of informational sheets, videos, articles, and external links. You will be encouraged to read and

view this information each week. This part of the website is meant to assist you in obtaining knowledge, skills, and attitudes that will help you meet your walking goals. The study website will also have a section (the discussion board) where you can share information with other participants. This part of the website is meant to provide encouragement and support for you while you are working to become more active. You will be encouraged to enter the discussion board portion of the website a minimum of three times each week to view and draft posts. The study leader, Courtney Monroe, will also access this discussion board and provide feedback and information for participants. The study researchers will track data that you put into the website and also track how often you log into the website.

At the end of the eight-week study, you will return to the laboratory in order to repeat the tests that were performed during the first visit. We will also ask you to complete a survey about which parts of the research study were most satisfying for you. This testing period will last approximately 75 minutes. You will also return your pedometer to the researchers at this meeting.

POTENTIAL RISKS

The risks associated with light-to-moderate-intensity physical activity/exercise, including musculoskeletal injuries, fatigue, nausea, breathlessness, lightheadedness, dizziness, fainting, mild muscle soreness, abnormal blood pressure responses, and heart attack, are very low in healthy individuals. The probability of experiencing an injury at the onset of a walking program is low. Individuals who are at increased risk for experiencing these responses will not be enrolled in the study. No known risks exist concerning the other laboratory tests you will complete.

BENEFITS OF PARTICIPATION

You will receive your height, weight, body fat percentage, waist circumference, and blood pressure values. You will also obtain information and advice concerning physical activity and exercise, and in turn, perhaps gain some of the skills, attitudes, and knowledge necessary to lead a physically active lifestyle.

CONFIDENTIALITY

All collected data will be treated as confidential. Identification numbers will be used on our data sheets to identify you as opposed to personal identifiers, such as your name and date of birth among others. Data will be stored in a locked file cabinet in the Health, Physical Education, and Recreation building (room 136C). All collected data, including data tied to Blackboard Learn, will only be accessible to us. The collected information will be used in research reports and presentations; however, your name and other personal identifiers will not be disclosed.

COMPENSATION

There will be no financial compensation for your participation in this study

EMERGENCY MEDICAL TREATMENT

The University of Tennessee does not automatically reimburse you for medical claims or other compensation. If physical injury is suffered in the course of research, or for more information, please notify the investigator in charge (Courtney Monroe; 865-974-6040).

CONTACT INFORMATION

If you have questions at any time about the study or the procedures, (or you experience adverse effects as a result of participating in this study,) you may contact Courtney Monroe, at The University of Tennessee, 1914 Andy Holt Avenue, Knoxville, TN 37996 or (865)-974-6040. If you have any questions about your rights as a participant, please contact the Office of Research Compliance Officer at (865) 974-3466.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed, any data collected from you may be used for research unless you specify otherwise. If you do not wish for your data to be used for research, please let the investigator (Courtney Monroe) know, and it will be destroyed.

CONSENT

By signing this consent form, I am indicating that I have read the above information, received a copy of this form, and agree to participate in the study.

Print Name

Your signature

Investigator's signature

Date

Date



ATTENTION UTK FACULTY AND STAFF!! VOLUNTEERS NEEDED FOR A RESEARCH STUDY

Researchers from the Department of Kinesiology, Recreation, and Sport Studies at UT are conducting a research study this fall. The study involves the examination of the usefulness of an **eight-week, Internet-based intervention for promoting walking** among university faculty and staff.

You may be able to participate if:

- you are a UTK faculty or staff member
- you are sedentary/insufficiently active
- you are between the ages of 18 and 64 years



✓ ***Eligible participants will have the opportunity to:**

- ❑ *ACCESS A SUPPORTIVE WEBSITE*
- ❑ *WEAR A PEDOMETER (STEP COUNTER) DURING THE STUDY*
- ❑ *UNDERGO THE FOLLOWING **FREE** HEALTH/FITNESS-RELATED TESTS:*



1. Blood Pressure
2. Body Composition
3. Waist Circumference
4. Height and Weight

*You will receive training on how to use the supportive website (one 60-minute session) and undergo the health/fitness-related tests at the beginning and end of the intervention (75 minutes per session). All training and testing will take place in the Applied Exercise Physiology Laboratory in the HPER Building on the UT campus. All data will be kept strictly confidential.



If you are interested in participating, or would like more information, then please contact Courtney Monroe (e-mail: cmonroe9@utk.edu) or (phone: 865-974-6040)

Attention UTK faculty and staff:

Thinking about walking more on a regular basis in an effort to improve your health/fitness, but would like some motivation, support, ideas, and advice to help ensure success? Want to be part of an innovative UTK program that delivers all of the help you need in one of the most convenient and accessible ways possible? If you answered yes, then it is time for you to consider becoming part of an exciting, new study centered on the usefulness of a Blackboard Internet-technology intervention for promoting walking among university faculty and staff.

If you are a UTK faculty or staff member who is relatively inactive/insufficiently active, as well as between the ages of 18 and 64 years, then you may be eligible to participate. Eligible participants will participate in an eight-week intervention this fall that will involve access to a supportive website, the use of a pedometer, and three visits to the Applied Exercise Physiology Laboratory in the Health, Physical Education, and Recreation building on the UT campus for a website training session (60 minutes) and FREE health/fitness testing (two 75-minute sessions). Please find attached a recruitment flyer, which contains pertinent information about the study.

If you are interested in participating in the study or would like more information about it, then please contact Courtney Monroe (study leader) right away. Thank you.

E-mail: cmonroe9@utk.edu

Office: 865-974-6040

Are you a UTK faculty or staff member who is thinking about walking more on a regular basis in an effort to improve your health/fitness, but would like some motivation, support, ideas, and advice to help ensure success? Want to be part of an innovative UTK program that delivers all of the help you need in one of the most convenient and accessible ways possible? If you answered yes, then it is time for you to consider becoming part of an exciting, new study centered on the usefulness of a Blackboard Internet- technology intervention for promoting walking among university faculty and staff.

If you are relatively inactive/insufficiently active, as well as between the ages of 18 and 64 years, then you may be eligible to participate. Eligible participants will participate in an eight-week intervention this fall that will involve access to a supportive website, the use of a pedometer, and three visits to the Applied Exercise Physiology Laboratory in the Health, Physical Education, and Recreation building on the UT campus for a website training session (60 minutes) and FREE health/fitness testing (two 75-minute sessions).

If you are interested in participating in the study or would like more information about it, then please contact Courtney Monroe (study leader) right away (e-mail: cmonroe9@utk.edu; phone: 865-974-6040).

Appendix B
Part III and Part IV
Health History Questionnaire

HEALTH HISTORY QUESTIONNAIRE

SUBJECT NUMBER _____

DATE _____

Please complete this form. This information will only be used for research purposes and will not be made public.

Please circle one choice for each item.

PHYSICAL ACTIVITY

1. Are you currently participating in a program to increase your physical activity level? If yes, please describe.

Yes No

2. Are you able to walk 1/4 mile continuously without pain or discomfort?

Yes No

3. Do you have an implanted pacemaker or defibrillator?

Yes No

PRESENT SYMPTOM REVIEW

4. Have you recently had any of the following symptoms? Please check the appropriate column.

| SYMPTOM | YES | NO |
|---|-----|----|
| Pain or discomfort in the chest, neck, jaw, or arms | | |
| Shortness of breath | | |
| Heart palpitations | | |
| Severe headache | | |
| Coughing up blood | | |
| Low blood sugar | | |
| Feeling faint or dizzy | | |
| Leg numbness | | |
| Frequent urination | | |
| Blood in urine | | |
| Leg or ankle swelling | | |
| Significant emotional problem | | |
| Blurred vision | | |
| Difficulty walking | | |
| Weakness in arm | | |

Please circle one choice for each item.

5. Do you currently smoke?

Yes

No

6. Are you taking any medications? If yes, please describe.

Yes

No

7. Are you currently pregnant or planning to become pregnant during the next 3 months?

Yes

No

Not Applicable

I have been given the opportunity to ask questions about any of the above items that were unclear, and I have answered all questions completely and truthfully to the best of my knowledge.

PRINT NAME_____

SIGNATURE_____

DATE_____

Appendix C
Part III and Part IV
Physical Activity Readiness Questionnaire

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

| YES | NO | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | 1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor? |
| <input type="checkbox"/> | <input type="checkbox"/> | 2. Do you feel pain in your chest when you do physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 3. In the past month, have you had chest pain when you were not doing physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 4. Do you lose your balance because of dizziness or do you ever lose consciousness? |
| <input type="checkbox"/> | <input type="checkbox"/> | 5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition? |
| <input type="checkbox"/> | <input type="checkbox"/> | 7. Do you know of <u>any other reason</u> why you should not do physical activity? |

If
you
answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____

DATE _____

SIGNATURE OF PARENT
or GUARDIAN (for participants under the age of majority) _____

WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.



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Appendix D

Part III

General Information Questionnaire

GENERAL INFORMATION QUESTIONNAIRE

SUBJECT NUMBER_____

DATE_____

Please complete this form. This information will only be used for research purposes and will not be made public.

AGE_____

DATE OF BIRTH_____

Please circle one choice for each item.

SEX: Male Female

RACE: Caucasian African-American Asian-American Other

EMPLOYMENT CLASSIFICATION: Faculty Staff

EDUCATIONAL ATTAINMENT:

High school diploma or GED Some college Bachelor's degree
Graduate degree

1. Are you comfortable using a computer to access the Internet?

Yes No

2. Do you have access to the Internet at home?

Yes No

(If you answered "No," then skip to question # 4).

3. Approximately how often do you use the Internet at home?

Never Less than or equal to 4 times per month Several times a week

Almost everyday Daily

4. Do you have access to the Internet at work?

Yes No

(If you answered “No,” then you have reached the end of the questionnaire).

5. Approximately how often do you use the Internet at work?

Never Less than or equal to 4 times per month Several times a week

Almost everyday Daily

Appendix E

Part III

International Physical Activity Questionnaire

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

☐

No vigorous physical activities



Skip to question 3

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐

Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

☐

No moderate physical activities



Skip to question 5

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?
_____ **days per week**

☐ No walking ➔ *Skip to question 7*

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

Appendix F

Part III

Social Support for Exercise Scale

SOCIAL SUPPORT FOR EXERCISE SCALE

The following questions refer to social support for your exercise.

The following is a list of things people might do or say to someone who is trying to exercise regularly. Please read and answer every question. If you are not trying to exercise, then some of the questions may not apply to you.

Please rate each question *twice*. Under “Family,” rate how often anyone living in your household has said or done what is described during the past 3 months. Under “Friends,” rate how often your friends, acquaintances, or coworkers have said or done what is described during the past 3 months.

| | | |
|--|---------------|----------------|
| Please write <i>one</i> number from the following rating scale in each space: | | |
| 1 = none 2 = rarely 3 = a few times 4 = often 5 = very often 0 = does not apply | | |
| | Family | Friends |
| 1. Exercised with me | | |
| 2. Offered to exercise with me | | |
| 3. Gave me helpful reminders to exercise (“Are you going to exercise tonight?”) | | |
| 4. Gave me encouragement, to stick with my exercise program | | |
| 5. Changed their schedule so we could exercise together | | |
| 6. Discussed exercise with me | | |
| 7. Complained about the time I spend exercising | | |
| 8. Criticized me or made fun of me for exercising | | |
| 9. Gave me rewards for exercising (bought me something or gave me something I like) | | |
| 10. Planned for exercise on recreational outings | | |
| 11. Helped plan events around my exercise | | |
| 12. Asked me for ideas on how they can get more exercise | | |
| 13. Talked about how much they like to exercise | | |

Appendix G
Part III and Part IV
Barriers Self-efficacy Scale

The following items reflect situations that are listed as common reasons for preventing individuals from participating in exercise sessions or, in some cases, dropping out. Using the scales below please indicate how confident you are that you could exercise in the event that any of the following circumstances were to occur.

Please indicate the degree to which you are confident that you could exercise in the event that any of the following circumstances were to occur by circling the appropriate %. Select the response that most closely matches your own, remembering that there are no right or wrong answers.

FOR EXAMPLE:

In question #1 if you have complete confidence that you could exercise even if "the weather was very bad," you would circle 100%. If however, you had no confidence at all that you could exercise (that is, confidence you would not exercise), you would circle 0%.

| | | | | | | | | | | |
|------------|----|----|----|----|------------|----|----|----|----|-----------|
| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Not at all | | | | | Moderately | | | | | Highly |
| Confident | | | | | Confident | | | | | Confident |

I believe that I could exercise 3 times per week for the next 3 months if:

1. The weather was very bad (hot, humid, rainy, cold).

| | | | | | | | | | | |
|------------|----|----|----|----|------------|----|----|----|----|-----------|
| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Not at all | | | | | Moderately | | | | | Highly |
| Confident | | | | | Confident | | | | | Confident |
2. I was bored by the program or activity.

| | | | | | | | | | | |
|------------|----|----|----|----|------------|----|----|----|----|-----------|
| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Not at all | | | | | Moderately | | | | | Highly |
| Confident | | | | | Confident | | | | | Confident |
3. I was on vacation.

| | | | | | | | | | | |
|------------|----|----|----|----|------------|----|----|----|----|-----------|
| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Not at all | | | | | Moderately | | | | | Highly |
| Confident | | | | | Confident | | | | | Confident |
4. I was not interested in the activity.

| | | | | | | | | | | |
|------------|----|----|----|----|------------|----|----|----|----|-----------|
| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Not at all | | | | | Moderately | | | | | Highly |
| Confident | | | | | Confident | | | | | Confident |
5. I felt pain or discomfort when exercising.

| | | | | | | | | | | |
|------------|----|----|----|----|------------|----|----|----|----|-----------|
| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Not at all | | | | | Moderately | | | | | Highly |
| Confident | | | | | Confident | | | | | Confident |

I believe that I could exercise 3 times per week for the next 3 months if:

6. I had to exercise alone.
 0 10 20 30 40 50 60 70 80 90 100
 Not at all Moderately Highly
 Confident Confident Confident
7. It was not fun or enjoyable.
 0 10 20 30 40 50 60 70 80 90 100
 Not at all Moderately Highly
 Confident Confident Confident
8. It became difficult to get to the exercise location.
 0 10 20 30 40 50 60 70 80 90 100
 Not at all Moderately Highly
 Confident Confident Confident
9. I didn't like the particular activity program that I was involved in.
 0 10 20 30 40 50 60 70 80 90 100
 Not at all Moderately Highly
 Confident Confident Confident
10. My schedule conflicted with my exercise session.
 0 10 20 30 40 50 60 70 80 90 100
 Not at all Moderately Highly
 Confident Confident Confident
11. I felt self-conscious about my appearance when I exercised.
 0 10 20 30 40 50 60 70 80 90 100
 Not at all Moderately Highly
 Confident Confident Confident
12. An instructor does not offer me any encouragement.
 0 10 20 30 40 50 60 70 80 90 100
 Not at all Moderately Highly
 Confident Confident Confident
13. I was under personal stress of some kind.
 0 10 20 30 40 50 60 70 80 90 100
 Not at all Moderately Highly
 Confident Confident Confident

Appendix H
Part III and Part IV
Multidimensional Outcome Expectations for Exercise Scale

INSTRUCTIONS: The following items reflect your beliefs or expectations about the benefits of regular exercise or physical activity. Please respond to the following statements marking your answer honestly and by circling the appropriate number/statement. Remember to read each question carefully.

EXAMPLE:

Q) **Exercise will...**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

1) **Exercise will improve my ability to perform daily activities:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

2) **Exercise will improve my social standing:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

3) **Exercise will improve my overall body functioning:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

4) **Exercise will help manage stress:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

5) **Exercise will strengthen my bones:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

6) **Exercise will improve my mood:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

7) **Exercise will increase my muscle strength:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

8) **Exercise will make me more at ease with people:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

9) **Exercise will aid in weight control:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

10) **Exercise will improve my psychological state:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

11) **Exercise will provide companionship:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

12) **Exercise will improve the functioning of my cardiovascular system:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

13) **Exercise will increase my mental alertness:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

14) **Exercise will increase my acceptance by others:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

15) **Exercise will give me a sense of personal accomplishment:**

| | | | | |
|---------------------------|---------------|--------------|------------|------------------------|
| 1 STRONGLY DISAGREE | 2 DISAGREE | 3 NEUTRAL | 4 AGREE | 5 STRONGLY AGREE |
|---------------------------|---------------|--------------|------------|------------------------|

Appendix I

Part III and Part IV

Exercise Goal-setting Scale and Exercise Planning and Scheduling Scale

Exercise Goals

The following questions refer to how you set exercise goals and plan exercise activities. Please indicate the extent to which each of the statements below describes you:

| | <u>Does not Describe</u> | | <u>Describes Moderately</u> | | <u>Describes Completely</u> |
|---|-------------------------------------|---|--|---|--|
| 1. I often set exercise goals. | 1 | 2 | 3 | 4 | 5 |
| 2. I usually have more than one major exercise goal. | 1 | 2 | 3 | 4 | 5 |
| 3. I usually set dates for achieving my exercise goals | 1 | 2 | 3 | 4 | 5 |
| 4. My exercise goals help to increase my motivation for doing exercise | 1 | 2 | 3 | 4 | 5 |
| 5. I tend to break more difficult exercise goals down into a series of smaller goals | 1 | 2 | 3 | 4 | 5 |
| 6. I usually keep track of my progress in meeting my goals | 1 | 2 | 3 | 4 | 5 |
| 7. I have developed a series of steps for reaching my exercise goals | 1 | 2 | 3 | 4 | 5 |
| 8. I usually achieve the exercise goals I set for myself. | 1 | 2 | 3 | 4 | 5 |
| 9. If I do not reach an exercise goal, I analyze what went wrong | 1 | 2 | 3 | 4 | 5 |
| 10. I make my exercise goals public by telling other people about them | 1 | 2 | 3 | 4 | 5 |

Exercise Plans

The following questions refer to how you fit exercise into your lifestyle. Please indicate the extent to which each of the statements below describes you:

| | <u>Does not Describe</u> | | <u>Describes Moderately</u> | | <u>Describes Completely</u> |
|--|-------------------------------------|---|--|---|--|
| 1. I never seem to have enough time to exercise | 1 | 2 | 3 | 4 | 5 |
| 2. *Exercise is generally not a high priority when I plan my schedule | 1 | 2 | 3 | 4 | 5 |
| 3. *Finding time for exercise is difficult for me | 1 | 2 | 3 | 4 | 5 |
| 4. I schedule all events in my life around my exercise routine. | 1 | 2 | 3 | 4 | 5 |
| 5. I schedule my exercise at specific times each week. | 1 | 2 | 3 | 4 | 5 |
| 6. I plan my weekly exercise schedule. | 1 | 2 | 3 | 4 | 5 |
| 7. *When I am very busy, I don't do much exercise | 1 | 2 | 3 | 4 | 5 |
| 8. Everything is scheduled around my exercise routine—both classes and work . . | 1 | 2 | 3 | 4 | 5 |
| 9. I try to exercise at the same time and same day each week to keep a routine going. | 1 | 2 | 3 | 4 | 5 |
| 10. I write my planned activity sessions in an appointment book or calendar | 1 | 2 | 3 | 4 | 5 |

*reversely scored items

Appendix J
Part III
Satisfaction Questionnaire

PLEASE READ THESE INSTRUCTIONS

The purpose of this questionnaire is to determine the extent of your use of and satisfaction with the online walking program. The information obtained from this questionnaire will allow us (investigators) to (1) explore the relationship between the components of the online walking program and physical activity behavior, exercise-related thoughts/experiences, and retention and (2) gain a better understanding of the strengths and weaknesses of the online walking program, which will help inform the refinement of it. When you are ready to begin, please read each statement or question. Choose your answer and circle the corresponding number or check the corresponding box. Please answer the open-ended questions if applicable, as well. If you have any questions, please ask the study leader, Courtney Monroe.

Website Access

| Question | Never | Less than one time per week | Weekly | Several times per week | Daily | More than one time per day |
|---|-------|-----------------------------|--------|------------------------|-------|----------------------------|
| 1. On average, how often did you log-on to the website during the duration of the entire eight-week study? <i>(If you answered "Never," then skip to question # 14)</i> | 1 | 2 | 3 | 4 | 5 | 6 |

Tutorial

| Statement | | Yes | No | | |
|--|-------------------|--------------------------|--------------------------|-------|----------------|
| 2. I watched part or all of the video tutorial. (If you answered "No," then skip to question #4) | | <input type="checkbox"/> | <input type="checkbox"/> | | |
| 3. I thought the tutorial was helpful. | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| | 1 | 2 | 3 | 4 | 5 |

Educational/Motivational Components

| Statement | Never | Seldom | Sometimes | Usually | Always |
|--|--------------------------|--------------------------|------------|---------|--------|
| 4. I read the motivational tips (If you answered “Never,” then skip to question #6) | 1 | 2 | 3 | 4 | 5 |
| 5. I actually applied at least some of the strategies and/or information provided via the motivational tips. | Yes | No | | | |
| | <input type="checkbox"/> | <input type="checkbox"/> | | | |
| Question | None | Some | About Half | Most | All |
| 6. How many of the eight weekly informational folders did you access at least once? (If you answered “None,” then skip to question # 14) | 1 | 2 | 3 | 4 | 5 |
| 7. I read the informational handout (at least once) that was part of each weekly folder I accessed. | 1 | 2 | 3 | 4 | 5 |
| 8. I read the article or articles (at least once) that was/were part of each weekly folder I accessed. | 1 | 2 | 3 | 4 | 5 |

| Statement | Never | Seldom | Sometimes | Usually | Always |
|---|--------------------------|-----------------|------------------|--------------|-----------------------|
| 9. I viewed the video or videos (at least once) that was/were part of each weekly folder I accessed. | 1 | 2 | 3 | 4 | 5 |
| 10. I clicked on the external link or links (at least once) that was/were part of each weekly folder I accessed. | 1 | 2 | 3 | 4 | 5 |
| 11. Overall, I thought the materials in each weekly folder that I accessed were easy to understand. | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| | 1 | 2 | 3 | 4 | 5 |
| 12. Overall, I thought the materials in each weekly folder that I accessed were useful. | 1 | 2 | 3 | 4 | 5 |
| 13. Overall, I actually applied at least some of the strategies and/or information provided via each weekly folder that I accessed. | 1 | 2 | 3 | 4 | 5 |

Pedometer and Physical Activity Log

| Question | Never | Seldom | Sometimes | Usually | Always |
|--|--------------------------|--------------------------|------------------|--------------|-----------------------|
| 14. I wore my pedometer as advised during the duration of the eight-week study. (If you answered "Never," then skip to question # 22) | 1 | 2 | 3 | 4 | 5 |
| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| 15. I thought the pedometer was a useful and supportive tool. | 1 | 2 | 3 | 4 | 5 |
| 16. I enjoyed using the pedometer. | 1 | 2 | 3 | 4 | 5 |
| 17. I thought it was difficult to meet the daily step goal. | 1 | 2 | 3 | 4 | 5 |
| 18. I used the online physical activity log to report my steps and received feedback at least once during the duration of the eight-week study. (If you answered "No," then skip to question # 22) | Yes | No | | | |
| | <input type="checkbox"/> | <input type="checkbox"/> | | | |
| 19. I thought the online physical activity log was easy to use. | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| | 1 | 2 | 3 | 4 | 5 |
| 20. I thought the online physical activity log was useful. | 1 | 2 | 3 | 4 | 5 |
| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| 21. I thought the feedback I received after I submitted each weekly physical activity log was helpful. | 1 | 2 | 3 | 4 | 5 |

Communication

| Statement | Never | Less than one time per week | Weekly | Several times per week | Daily | More than one time per day |
|--|-------|-----------------------------|--------|------------------------|-------|----------------------------|
| 22. On average, how often did you access the discussion board to <u>read</u> posts by other individuals during the duration of the eight-week study? | 1 | 2 | 3 | 4 | 5 | 6 |
| 23. On average, how often did you access the discussion board to <u>draft</u> posts during the duration of the eight-week study? | 1 | 2 | 3 | 4 | 5 | 6 |

(If you answered "Never" for both question # 22 and question # 23, then skip to question # 27)

| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
|---|-------------------|----------|-----------|-------|----------------|
| 24. I thought the discussion board was easy to use. | 1 | 2 | 3 | 4 | 5 |
| 25. I liked the format of the discussion board. | 1 | 2 | 3 | 4 | 5 |
| 26. I thought the discussion board was helpful. | 1 | 2 | 3 | 4 | 5 |

| Statement | Yes | No | | | |
|---|--------------------------|--------------------------|-----------|-------|----------------|
| 27. I participated in a live chat at least once during the duration of the eight-week study. (If you answered “No,” then skip to question # 30) | <input type="checkbox"/> | <input type="checkbox"/> | | | |
| 28. I thought the live chat function was easy to use. | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| | 1 | 2 | 3 | 4 | 5 |
| | 1 | 2 | 3 | 4 | 5 |
| 29. I thought the live chat function was helpful. | 1 | 2 | 3 | 4 | 5 |

| Statement | Yes | No | | | |
|--|--------------------------|--------------------------|-----------|---------|----------------|
| 30. I contacted the investigator at least once during the duration of the eight-week study, using the messaging function. <i>(If you answered “No,” then skip to question # 35)</i> | <input type="checkbox"/> | <input type="checkbox"/> | | | |
| 31. I read the message(s) I received from the investigator in response to my message(s). | Never | Seldom | Sometimes | Usually | Always |
| | 1 | 2 | 3 | 4 | 5 |
| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| 32. I thought the message system was easy to use. | 1 | 2 | 3 | 4 | 5 |
| 33. I thought the reply (or replies) I received from the investigator was/were timely. | 1 | 2 | 3 | 4 | 5 |
| 34. I thought the reply (or replies) I received from the investigator was/were helpful. | 1 | 2 | 3 | 4 | 5 |

Overall

| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
|--|------------------------------|-----------------|------------------|--------------|---------------------------|
| 35. I thought the study website was easy to use/navigate. | 1 | 2 | 3 | 4 | 5 |
| 36. I thought the study website was attention grabbing. | 1 | 2 | 3 | 4 | 5 |
| 37. Overall, I thought the study website was easy to understand. | 1 | 2 | 3 | 4 | 5 |
| 38. Overall, I thought the study website was helpful. | 1 | 2 | 3 | 4 | 5 |
| 39. Overall, I actually applied at least some of the strategies and/or information provided via the study website. | 1 | 2 | 3 | 4 | 5 |
| 40. I plan to continue using the strategies and information I gathered from the study website. | 1 | 2 | 3 | 4 | 5 |
| 41. Overall, I was satisfied with the online walking program. | 1 | 2 | 3 | 4 | 5 |
| 42. I would recommend this online walking program to a friend, co-worker, and/or family member. | 1 | 2 | 3 | 4 | 5 |

43. Please list the main barriers/challenges to using the study website that you encountered during the length of the program.
44. Which aspects of the online walking program do you feel helped you the most with your effort to become and stay physically active?
45. What did you dislike about the online walking program?
46. Do you have any suggestions or recommendations related to the improvement of or modifications that should be considered for the online walking program? If so, please list them.

Appendix K

Part IV

Informed Consent Forms, Recruitment Flyer, E-mail, Electronic Announcement, Newspaper Advertisement, and Letter

INFORMED CONSENT FORM

Knoxville Moves: Log-in and Get Mobile

Principal Investigator: Courtney Monroe

Address: Department of Kinesiology, Recreation, and Sport Studies

College of Education, Health, and Human Sciences

The University of Tennessee

1914 Andy Holt Avenue

303 HPER Bldg.

Knoxville, TN 37996-2700

Phone: (865) 974-6040

E-mail: cmonroe9@utk.edu

STUDY PURPOSE

You are invited to take part in a research study entitled “Knoxville Moves: Log-in and Get Mobile.” The goal of this study is to examine the usefulness of an Internet- and smartphone-based program for promoting walking among adults. The study specifically involves the examination of how well the different features of the online walking program work. If you give your consent, you will attend a testing session in the Applied Exercise Physiology Laboratory in the Health, Physical Education, and Recreation Building (room 318) on the University of Tennessee campus that will last approximately 75 minutes. You will not eat or drink within four hours of the tests. You will not perform any exercise within 12 hours of the tests. You will need to bring (or wear) shorts and a t-shirt to this testing session.

TESTING PROTOCOL

1. You will initially complete four questionnaires (general information, health history, physical activity readiness, and physical activity level).
2. Your resting blood pressure will be measured in your right arm using a blood pressure cuff like you may have experienced in a doctor’s office. You will sit in a chair for five minutes prior to the measurement. Two measurements will be made at least one minute apart in order to ensure accuracy.
3. Your height, weight, and body fat percentage will be measured. For these measurements you will be asked to remove your shoes and socks. We will measure your body fat percentage, using the bioelectrical impedance analysis (B.I.A.) technique. The machine we use looks like standard bathroom scales with handles added. This measurement involves a low-level electrical current that is used to determine how much lean tissue and fat tissue is in your body. This procedure takes less than a minute and just requires you to stand on the scale while holding onto the handles.

The information from these tests will be used in part to confirm your eligibility for this study. If you do not meet the eligibility criteria, then the testing process will end, and you will not be able to participate in the study. You will be given the collected health information.

4. The distance around your waist will be measured with a tape measure. Two measurements will be made in order to ensure accuracy.

5. You will complete four additional questionnaires. The questions are related to your thoughts and experiences related to exercise.

6. Finally, we will ask you to walk in the hallway at a normal pace for about 20 feet. We use that test to see how far you move with each step – your stride length. That information will be entered into a pedometer so we can estimate how far you walk each day. You will be given a pedometer to use during the study.

After this testing, we will ask you to wear a pedometer for one week while going about your normal routine. During this week, we ask that you place the pedometer in your front pocket or on your belt or waistband. You will wear it during all waking hours (except when swimming or showering). You should not change your usual activity patterns during this one-week time period. During this week, a piece of tape will be placed over the pedometer display to prevent you from seeing the step counts. At the end of this week, you will return to the laboratory so we can collect information from your pedometer. We will use this information to confirm your eligibility for the study in terms of habitual physical activity level (sedentary/insufficiently active). If you do not meet the eligibility criteria, then the testing process will end, and you will not be able to participate in the study. You will be given the collected health information. If you do meet the eligibility criteria, you will be shown how to use the physical activity-related websites and smartphone application. The study leader will let you know that you will be connected with four other participants online when you start the first week of the program. You will be encouraged to interact with these four other participants throughout the program. You will be asked to think about what you want to discuss with the other four participants during your initial online meeting with them (e.g., introductions, why you joined the walking program, what you hope to gain from the walking program). This second visit will last about 75 minutes.

BLACKBOARD LEARN (CourseSites) AND EXERCISE TRAINING

If you complete all testing, the one-week walking period, and you meet all eligibility requirements, you will be granted access to the physical activity-related websites and smartphone application. You will be assigned to one of two groups. Since, the study specifically involves the examination of how well the different features of this online program work, every participant will not have access to the same features. You will access one website (Omron website) using your own e-mail address and a password issued to you by the study leader. You will access another website through Blackboard Learn (CourseSites). This will require the use of your personal username and password. You are asked to view two tutorials the first time you access it. These tutorials will show you how to use the Internet/smartphone intervention. You will also wear the pedometer everyday during waking hours (except when swimming or showering) throughout the 12-week study.

You will receive a minimum physical activity recommendation that will use a daily step goal. You will be encouraged to walk at least 3,000 steps above your average daily baseline step count on at least 5 days each week for 12 weeks. You will be encouraged to gradually increase the

number of steps you take until you reach this goal. You will upload your pedometer data to the Omron website and also log your steps and physical activity through the Blackboard Learn website.

The supportive Blackboard Learn website will provide information about staying active. You will be encouraged to read and view this information. It will also have sections (discussion board, instant message system, and live chats) where you can share information with the other four participants you connect with online during the first week of the program. You will be encouraged to enter the discussion board a minimum of three times each week to view and draft posts. The study leader will also access this discussion board and provide information for the participants, sending an e-mail and posting an announcement when a new message has been posted. You will also be encouraged to access and use the instant message and live chat features. The study researchers will track data that you put into both the Blackboard Learn website and Omron website and also track how often you log in to the Blackboard Learn website.

At the midpoint of the study (6 weeks), you will receive an e-mail from the study leader. You will be asked to complete four questionnaires about your thoughts and experiences related to exercise. These questionnaires will be administered online.

At the end of the 12-week study, you will return to the laboratory in order to repeat the tests that were performed during the first visit. We will also ask you to complete a survey about which parts of the research study were most satisfying for you. This testing period will last approximately 75 minutes. You will also return your pedometer to the researchers at this meeting.

One-year after the completion of the study, we will contact you via telephone or e-mail and ask you to complete two physical activity-related questionnaires by e-mail.

POTENTIAL RISKS

The risks associated with light-to-moderate-intensity physical activity/exercise, including musculoskeletal injuries, fatigue, nausea, breathlessness, lightheadedness, dizziness, fainting, mild muscle soreness, abnormal blood pressure responses, and heart attack, are very low in healthy individuals. The probability of experiencing an injury at the onset of a walking program is low. Individuals who are at increased risk for experiencing these responses will not be enrolled in the study. No known risks exist concerning the other laboratory tests you will complete.

BENEFITS OF PARTICIPATION

You will receive your height, weight, body fat percentage, waist circumference, and blood pressure values. You will also obtain information and advice concerning physical activity and exercise, and in turn, perhaps gain some of the skills, attitudes, and knowledge necessary to lead a physically active lifestyle.

CONFIDENTIALITY

All collected data will be treated as confidential. Identification numbers will be used on our data sheets to identify you as opposed to personal identifiers, such as your name and date of birth among others. Data will be stored in a locked file cabinet in the Health, Physical Education, and Recreation building (room 136C). All collected data, including data tied to Blackboard Learn and the Omron website, will only be accessible to us. The collected information will be used in research reports and presentations; however, your name and other personal identifiers will not be disclosed.

COMPENSATION

There will be no financial compensation for your participation in this study.

EMERGENCY MEDICAL TREATMENT

The University of Tennessee does not automatically reimburse you for medical claims or other compensation. If physical injury is suffered in the course of research, or for more information, please notify the investigator in charge (Courtney Monroe; 865-974-6040).

CONTACT INFORMATION

If you have questions at any time about the study or the procedures, (or you experience adverse effects as a result of participating in this study,) you may contact Courtney Monroe, at The University of Tennessee, 1914 Andy Holt Avenue, Knoxville, TN 37996 or (865)-974-6040. If you have any questions about your rights as a participant, please contact the Office of Research Compliance Officer at (865) 974-3466.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed, any data collected from you may be used for research unless you specify otherwise. If you do not wish for your data to be used for research, please let the investigator (Courtney Monroe) know, and it will be destroyed.

CONSENT

By signing this consent form, I am indicating that I have read the above information, received a copy of this form, and agree to participate in the study.

Print Name

Your signature

Date

Investigator's signature

Date

INFORMED CONSENT FORM

Knoxville Moves: Log-in and Get Mobile

Principal Investigator: Courtney Monroe

Address: Department of Kinesiology, Recreation, and Sport Studies

College of Education, Health, and Human Sciences

The University of Tennessee

1914 Andy Holt Avenue

303 HPER Bldg.

Knoxville, TN 37996-2700

Phone: (865) 974-6040

E-mail: cmonroe9@utk.edu

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1. You will initially complete four questionnaires (general information, health history, physical activity readiness, and physical activity level).
2. Your resting blood pressure will be measured in your right arm using a blood pressure cuff like you may have experienced in a doctor’s office. You will sit in a chair for five minutes prior to the measurement. Two measurements will be made at least one minute apart in order to ensure accuracy.
3. Your height, weight, and body fat percentage will be measured. For these measurements you will be asked to remove your shoes and socks. We will measure your body fat percentage, using the bioelectrical impedance analysis (B.I.A.) technique. The machine we use looks like standard bathroom scales with handles added. This measurement involves a low-level electrical current that is used to determine how much lean tissue and fat tissue is in your body. This procedure takes less than a minute and just requires you to stand on the scale while holding onto the handles.

The information from these tests will be used in part to confirm your eligibility for this study. If you do not meet the eligibility criteria, then the testing process will end, and you will not be able to participate in the study. You will be given the collected health information.

4. The distance around your waist will be measured with a tape measure. Two measurements will be made in order to ensure accuracy.

5. You will complete four additional questionnaires. The questions are related to your thoughts and experiences related to exercise.

6. Finally, we will ask you to walk in the hallway at a normal pace for about 20 feet. We use that test to see how far you move with each step – your stride length. That information will be entered into a pedometer so we can estimate how far you walk each day. You will be given a pedometer to use during the study.

After this testing, we will ask you to wear a pedometer for one week while going about your normal routine. During this week, we ask that you place the pedometer in your front pocket or on your belt or waistband. You will wear it during all waking hours (except when swimming or showering). You should not change your usual activity patterns during this one-week time period. During this week, a piece of tape will be placed over the pedometer display to prevent you from seeing the step counts. At the end of this week, you will return to the laboratory so we can collect information from your pedometer. We will use this information to confirm your eligibility for the study in terms of habitual physical activity level (sedentary/insufficiently active). If you do not meet the eligibility criteria, then the testing process will end, and you will not be able to participate in the study. You will be given the collected health information. If you do meet the eligibility criteria, you will be shown how to use the physical activity-related websites and smartphone application. This second visit will last about 75 minutes.

BLACKBOARD LEARN (CourseSites) AND EXERCISE TRAINING

If you complete all testing, the one-week walking period, and you meet all eligibility requirements, you will be granted access to the physical activity-related websites and smartphone application. You will be assigned to one of two groups. Since, the study specifically involves the examination of how well the different features of this online program work, every participant will not have access to the same features. You will access one website (Omron website) using your own e-mail address and a password issued to you by the study leader. You will access another website through Blackboard Learn (CourseSites). This will require the use of your personal username and password. You are asked to view two tutorials the first time you access it. These tutorials will show you how to use the Internet/smartphone intervention. You will also wear the pedometer everyday during waking hours (except when swimming or showering) throughout the 12-week study.

You will receive a minimum physical activity recommendation that will use a daily step goal. You will be encouraged to walk at least 3,000 steps above your average daily baseline step count on at least 5 days each week for 12 weeks. You will be encouraged to gradually increase the number of steps you take until you reach this goal. You will upload your pedometer data to the

Omron website and also log your steps and physical activity through the Blackboard Learn website.

The supportive Blackboard Learn website will provide information about staying active. You will be encouraged to read and view this information. The study researchers will track data that you put into both the Blackboard Learn website and Omron website and also track how often you log in to the Blackboard Learn website.

At the midpoint of the study (6 weeks), you will receive an e-mail from the study leader. You will be asked to complete four questionnaires about your thoughts and experiences related to exercise. These questionnaires will be administered online.

At the end of the 12-week study, you will return to the laboratory in order to repeat the tests that were performed during the first visit. We will also ask you to complete a survey about which parts of the research study were most satisfying for you. This testing period will last approximately 75 minutes. You will also return your pedometer to the researchers at this meeting.

One-year after the completion of the study, we will contact you via telephone or e-mail and ask you to complete two physical activity-related questionnaires by e-mail.

POTENTIAL RISKS

The risks associated with light-to-moderate-intensity physical activity/exercise, including musculoskeletal injuries, fatigue, nausea, breathlessness, lightheadedness, dizziness, fainting, mild muscle soreness, abnormal blood pressure responses, and heart attack, are very low in healthy individuals. The probability of experiencing an injury at the onset of a walking program is low. Individuals who are at increased risk for experiencing these responses will not be enrolled in the study. No known risks exist concerning the other laboratory tests you will complete.

BENEFITS OF PARTICIPATION

You will receive your height, weight, body fat percentage, waist circumference, and blood pressure values. You will also obtain information and advice concerning physical activity and exercise, and in turn, perhaps gain some of the skills, attitudes, and knowledge necessary to lead a physically active lifestyle.

CONFIDENTIALITY

All collected data will be treated as confidential. Identification numbers will be used on our data sheets to identify you as opposed to personal identifiers, such as your name and date of birth among others. Data will be stored in a locked file cabinet in the Health, Physical Education, and Recreation building (room 136C). All collected data, including data tied to Blackboard Learn and the Omron website, will only be accessible to us. The collected information will be used in

research reports and presentations; however, your name and other personal identifiers will not be disclosed.

COMPENSATION

There will be no financial compensation for your participation in this study.

EMERGENCY MEDICAL TREATMENT

The University of Tennessee does not automatically reimburse you for medical claims or other compensation. If physical injury is suffered in the course of research, or for more information, please notify the investigator in charge (Courtney Monroe; 865-974-6040).

CONTACT INFORMATION

If you have questions at any time about the study or the procedures, (or you experience adverse effects as a result of participating in this study,) you may contact Courtney Monroe, at The University of Tennessee, 1914 Andy Holt Avenue, Knoxville, TN 37996 or (865)-974-6040. If you have any questions about your rights as a participant, please contact the Office of Research Compliance Officer at (865) 974-3466.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed, any data collected from you may be used for research unless you specify otherwise. If you do not wish for your data to be used for research, please let the investigator (Courtney Monroe) know, and it will be destroyed.

CONSENT

By signing this consent form, I am indicating that I have read the above information, received a copy of this form, and agree to participate in the study.

Print Name

Your signature

Date

Investigator's signature

Date



ATTENTION!! VOLUNTEERS NEEDED FOR A RESEARCH STUDY

Researchers from the Department of Kinesiology, Recreation, and Sport Studies at UT are conducting a research study. The study involves the examination of the usefulness of a **12-week, Internet- and smartphone-based program for promoting walking** among adults. You may be able to participate if:

- you are between the ages of 18 and 64 years
- you are sedentary/insufficiently physically active
- you own a smartphone



- ✓ ***Eligible participants will have the opportunity to:**
- ❑ ACCESS SUPPORTIVE WEBSITES AND A SMARTPHONE APPLICATION
 - ❑ WEAR A PEDOMETER (STEP COUNTER) DURING THE STUDY
 - ❑ UNDERGO THE FOLLOWING **FREE** HEALTH/FITNESS-RELATED TESTS:



1. Blood Pressure
2. Body Composition
3. Waist Circumference
4. Height and Weight



*You will receive training on how to use the supportive websites and smartphone application (one 75-minute session) and undergo the health/fitness-related tests at the beginning and end of the intervention (75 minutes per session). All training and testing will take place in the Applied Exercise Physiology Laboratory in the HPER Building on the UT campus. All data will be kept strictly confidential.



If you are interested in participating, or would like more information, then please contact Courtney Monroe (e-mail: cmonroe9@utk.edu) or (phone: 865-974-8804).

Courtney Monroe
cmonroe9@utk.edu

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Courtney Monroe
cmonroe9@utk.edu

Courtney Monroe
cmonroe9@utk.edu

Attention [insert name of group]:

Make a New Year's resolution to become more physically active or just been thinking about walking more on a regular basis for awhile now in an effort to improve your health/fitness, but would like some motivation, support, ideas, and advice to help ensure success? Want to be part of an innovative UTK program that delivers all of the help you need in one of the most convenient and accessible ways possible? If you answered yes, then it is time for you to consider becoming part of an exciting, new study centered on the usefulness of an Internet and smartphone technology intervention for promoting walking among adults. It is happening right now!

If you are between the ages of 18 and 64 years, relatively inactive/insufficiently physically active, and own a smartphone, then you may be eligible to participate. Eligible participants will participate in a 12-week program that will involve access to supportive websites and a supportive smartphone application, the use of a pedometer, and three visits to the Applied Exercise Physiology Laboratory in the Health, Physical Education, and Recreation building on the UTK campus for a website/smartphone application training session (75 minutes) and FREE health/fitness testing (two 75-minute sessions). Please find attached a recruitment flyer, which contains pertinent information about the study.

If you are interested in participating in the study or would like more information about it, then please contact Courtney Monroe (study leader) right away. Thank you.

E-mail: cmonroe9@utk.edu

Office: 865-974-8804

Make a New Year's resolution to become more physically active or just been thinking about walking more on a regular basis for awhile now in an effort to improve your health/fitness, but would like some motivation, support, ideas, and advice to help ensure success? Want to be part of an innovative UTK program that delivers all of the help you need in one of the most convenient and accessible ways possible? If you answered yes, then it is time for you to consider becoming part of an exciting, new study centered on the usefulness of an Internet and smartphone technology intervention for promoting walking among adults. It is happening right now!

If you own a smartphone, are relatively inactive/insufficiently physically active, and between the ages of 18 and 64 years, then you may be eligible to participate. Eligible participants will participate in a 12-week program that will involve access to supportive websites and a supportive smartphone application, the use of a pedometer, and three visits to the Applied Exercise Physiology Laboratory in the Health, Physical Education, and Recreation building on the UTK campus for a website/smartphone application training session (75 minutes) and FREE health/fitness testing (two 75-minute sessions).

If you are interested in participating in the study or would like more information about it, then please contact Courtney Monroe (study leader) right away

(e-mail: cmonroe9@utk.edu; phone: 865-974-8804).

**MAKE A NEW YEAR'S RESOLUTION
TO BECOME MORE ACTIVE OR
BEEN THINKING ABOUT BECOMING
MORE ACTIVE FOR AWHILE NOW?**

If you are between the ages of 18 and 64 years, insufficiently active, and own a smartphone, you may be eligible to participate in a free walking program. You will gain access to supportive websites, a smartphone application, and a pedometer. You will also obtain free health/fitness testing at the University of Tennessee.

Contact: Courtney Monroe
E-mail: cmonroe9@utk.edu
Phone: 865-974-8804

Log-in and get mobile!



2-3-14

Dear «First_Name»,

In the past, you have expressed interest in participating in studies at The Healthy Eating and Activity Laboratory (HEAL) at the University of Tennessee, Knoxville. We are excited to inform you about a new study that is being conducted through the Department of Kinesiology, Recreation, and Sport Studies at the University of Tennessee, Knoxville. This study is centered on the usefulness of an Internet and smartphone technology intervention for promoting walking among adults. It is happening right now! If you are between the ages of 18 and 64 years, relatively inactive or insufficiently physically active, and own a smartphone, then you may be eligible to participate. Eligible participants will participate in a 12-week program that will involve access to supportive websites and a supportive smartphone application, the use of a pedometer, and three visits to the Applied Exercise Physiology Laboratory in the Health, Physical Education, and Recreation building on the University of Tennessee campus for a website/smartphone application training session (75 minutes) and FREE health/fitness testing (two 75-minute sessions).

If you are interested in participating in the study or would like more information about it, then please contact Courtney Monroe (study leader) right away.

E-mail: cmonroe9@utk.edu

Office: 865-974-8804

Sincerely,

A handwritten signature in black ink, reading "Courtney Monroe". The signature is fluid and cursive, with the first name "Courtney" and last name "Monroe" clearly distinguishable.

Courtney Monroe, M.S., H.F.S.

Doctoral Candidate

Department of Kinesiology, Recreation, and Sport Studies

University of Tennessee-Knoxville

Appendix L

Part IV

General Information Questionnaire

GENERAL INFORMATION QUESTIONNAIRE

SUBJECT NUMBER_____

DATE_____

Please complete this form. This information will only be used for research purposes and will not be made public.

AGE_____ DATE OF BIRTH_____ E-MAIL_____

SMARTPHONE #_____

Please circle one choice for each item.

SEX: Male Female

Are you of Hispanic or Latino Origin? Yes No

RACE: Caucasian African-American Asian-American Multiracial
Other

EDUCATIONAL ATTAINMENT:

High school diploma or GED Some college Bachelor's degree
Graduate degree

1. Are you comfortable using a computer to access the Internet?

Yes No

2. Do you have access to the Internet at home?

Yes No

(If you answered "No," then skip to question # 4).

3. Approximately how often do you use the Internet at home?

Never Less than or equal to 4 times per month Several times a week

Almost everyday Daily

4. Do you have access to the Internet at work?

Yes No

(If you answered "No," then you have reached the end of the questionnaire).

5. Approximately how often do you use the Internet at work?

Never Less than or equal to 4 times per month Several times a week

Almost everyday Daily

6. Do you have access to a smartphone?

Yes No

Appendix M

Part IV

Social Support for Exercise Scale

Social Support for Exercise Scale

The following questions refer to social support for your exercise.

The following is a list of things people might do or say to someone who is trying to exercise regularly. Please read and answer every question. If you are not trying to exercise, then some of the questions may not apply to you.

Please rate each question *twice*. Under “Family,” rate how often anyone living in your household has said or done what is described during the past 3 months. Under “Friends,” rate how often your friends, acquaintances, or coworkers have said or done what is described during the past 3 months. Under “Online Network,” rate how often persons you connect with via online networks have said or done what is described during the past 3 months.

Please write *one* number from the following rating scale in each space:

- 1 = none
- 2 = rarely
- 3 = a few times
- 4 = often
- 5 = very often
- 8 = does not apply

| | Family | Friends | Online Network |
|---|--------|---------|----------------|
| 1. Exercised with me | | | |
| 2. Offered to exercise with me | | | |
| 3. Gave me helpful reminders to exercise (“Are you going to exercise tonight?”) | | | |
| 4. Gave me encouragement, to stick with my exercise program | | | |
| 5. Changed their schedule so we could exercise together | | | |
| 6. Discussed exercise with me | | | |
| 7. Complained about the time I spend exercising | | | |
| 8. Criticized me or made fun of me for exercising | | | |
| 9. Gave me rewards for exercising (bought me something or gave me something I like) | | | |
| 10. Planned for exercise on recreational outings | | | |
| 11. Helped plan events around my exercise | | | |
| 12. Asked me for ideas on how they can get more exercise | | | |
| 13. Talked about how much they like to exercise | | | |

Appendix N

Part IV

Satisfaction Questionnaire

PLEASE READ THESE INSTRUCTIONS FIRST

The purpose of this questionnaire is to determine the extent of your use of and satisfaction with the online walking program. The information obtained from this questionnaire will allow us (investigators) to (1) explore the relationship between the components of the online walking program and physical activity behavior, exercise-related thoughts/experiences, and retention and (2) gain a better understanding of the strengths and weaknesses of the online walking program, which will help inform the refinement of it. When you are ready to begin, please read each statement or question. Choose your answer and circle the corresponding number or check the corresponding box. Please answer the open-ended questions if applicable, as well. If you have any questions, please ask the study leader, Courtney Monroe.

Website Access

| Question | Never | Less than one time per week | Weekly | Several times per week | Daily | More than one time per day |
|--|-------|--------------------------------|--------|---------------------------|-------|-------------------------------|
| 1. On average, how often did you log-on to the Blackboard website during the duration of the entire 12-week study (<i>If you answered "Never," then skip to question # 17</i>) | 1 | 2 | 3 | 4 | 5 | 6 |

Smartphone application

| | Never | Seldom | Sometimes | Usually | Always |
|---|----------------------|----------|-----------|---------|-------------------|
| 2. I used the Blackboard Learn smartphone application during the duration of the 12-week study (<i>If you answered "Never," then skip to question #5</i>) | 1 | 2 | 3 | 4 | 5 |
| | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| 3. I thought the smartphone application was convenient. | 1 | 2 | 3 | 4 | 5 |
| 4. I thought the smartphone application was easy to navigate. | 1 | 2 | 3 | 4 | 5 |

Tutorial

| Statement | | Yes | No | | |
|---|-------------------|--------------------------|--------------------------|-------|----------------|
| 5. I watched part or all of the video tutorials. (If you answered "No," then skip to question #7) | | <input type="checkbox"/> | <input type="checkbox"/> | | |
| 6. I thought the tutorials were helpful. | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| | 1 | 2 | 3 | 4 | 5 |

Educational/Motivational Components

| Statement | Never | Seldom | Sometimes | Usually | Always |
|--|-------|--------|-----------|---------|--------|
| 7. I read the motivational tips (<i>If you answered "Never," then skip to question #9</i>) | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|---|--------------------------|--------------------------|-------------------|-------------|------------|
| | Yes | No | | | |
| 8. I actually applied at least some of the strategies and/or information provided via the motivational tips. | <input type="checkbox"/> | <input type="checkbox"/> | | | |
| Question | None | Some | About Half | Most | All |
| 9. How many of the informational folders did you access at least once? (If you answered "None," then skip to question # 17) | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|--|--------------------------|-----------------|------------------|----------------|-----------------------|
| Statement | Never | Seldom | Sometimes | Usually | Always |
| 10. I read the informational handout (at least once) that was part of each folder I accessed. | 1 | 2 | 3 | 4 | 5 |
| 11. I read the article or articles (at least once) that was/were part of each folder I accessed. | 1 | 2 | 3 | 4 | 5 |
| 12. I viewed the video or videos (at least once) that was/were part of each folder I accessed. | 1 | 2 | 3 | 4 | 5 |
| 13. I clicked on the external link or links (at least once) that was/were part of each folder I accessed. | 1 | 2 | 3 | 4 | 5 |
| 14. Overall, I thought the materials in each folder that I accessed were easy to understand. | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| | 1 | 2 | 3 | 4 | 5 |
| 15. Overall, I thought the materials in each folder that I accessed were useful. | 1 | 2 | 3 | 4 | 5 |
| 16. Overall, I actually applied at least some of the strategies and/or information provided via each folder that I accessed. | 1 | 2 | 3 | 4 | 5 |

Pedometer and Physical Activity Log

| | | | | | |
|--|--------------------------|-----------------|------------------|----------------|-----------------------|
| Question | Never | Seldom | Sometimes | Usually | Always |
| 17. I wore my pedometer as advised during the duration of the 12-week study. (If you answered "Never," then skip to question # 21) | 1 | 2 | 3 | 4 | 5 |
| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| 18. I thought the pedometer was a useful and supportive tool. | 1 | 2 | 3 | 4 | 5 |
| 19. I enjoyed using the pedometer. | 1 | 2 | 3 | 4 | 5 |
| 20. I thought it was difficult to meet the daily step goal. | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|--|--------------------------|--------------------------|------------------|--------------|-----------------------|
| 21. I used the online physical activity log on the Blackboard website to report my physical activity and/or uploaded my pedometer data to the Omron website at least once during the duration of the 12-week study. (If you answered "No," then skip to question # 27) | Yes | No | | | |
| | <input type="checkbox"/> | <input type="checkbox"/> | | | |
| 22. I thought the online physical activity log was easy to use. | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| | 1 | 2 | 3 | 4 | 5 |
| 23. I thought the online physical activity log was useful. | 1 | 2 | 3 | 4 | 5 |
| 24. I thought the Omron website was easy to use. | 1 | 2 | 3 | 4 | 5 |
| 25. I thought the Omron website was useful. | 1 | 2 | 3 | 4 | 5 |
| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| 26. I thought the feedback I received after I uploaded my steps/submitted my physical activity information was helpful. | 1 | 2 | 3 | 4 | 5 |

Communication (if applicable)

| | | | | | | |
|---|--------------|------------------------------------|---------------|-------------------------------|--------------|-----------------------------------|
| Statement | Never | Less than one time per week | Weekly | Several times per week | Daily | More than one time per day |
| 27. On average, how often did you access the discussion board to <u>read</u> posts by other individuals during the duration of the 12-week study? | 1 | 2 | 3 | 4 | 5 | 6 |
| 28. On average, how often did you access the discussion board to <u>draft</u> posts during the duration of the 12-week study? | 1 | 2 | 3 | 4 | 5 | 6 |

(If you answered "Never" for both question # 27 and question # 28, then skip to question # 33)

| | | | | | |
|--|--------------------------|-----------------|------------------|----------------|-----------------------|
| Statement | Never | Seldom | Sometimes | Usually | Always |
| 29. I used the Blackboard Learn smartphone application during the duration of the 12-week study to read and/or draft discussion board posts. | 1 | 2 | 3 | 4 | 5 |
| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| 30. I thought the discussion board was easy to use. | 1 | 2 | 3 | 4 | 5 |
| 31. I liked the format of the discussion board. | 1 | 2 | 3 | 4 | 5 |
| 32. I thought the discussion board was helpful. | 1 | 2 | 3 | 4 | 5 |

| | | |
|--|--------------------------|--------------------------|
| Statement | Yes | No |
| 33. I participated in a live chat at least once during the duration of the 12-week study. (If you answered "No," then skip to question # 36) | <input type="checkbox"/> | <input type="checkbox"/> |

| | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
|---|--------------------------|-----------------|------------------|--------------|-----------------------|
| 34. I thought the live chat function was easy to use. | 1 | 2 | 3 | 4 | 5 |
| 35. I thought the live chat function was helpful. | 1 | 2 | 3 | 4 | 5 |

| Statement | Yes | No | | | |
|---|--------------------------|--------------------------|------------------|--------------|-----------------------|
| 36. I used the instant message function at least once during the duration of the 12-week study. <i>(If you answered "No," then skip to question # 39)</i> | <input type="checkbox"/> | <input type="checkbox"/> | | | |
| | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
| 37. I thought the instant message function was easy to use. | 1 | 2 | 3 | 4 | 5 |
| 38. I thought the instant message function was helpful. | 1 | 2 | 3 | 4 | 5 |

| Statement | Yes | No | | | |
|--|--------------------------|--------------------------|------------------|----------------|---------------|
| 39. I contacted the investigator at least once during the duration of the 12-week study. <i>(If you answered "No," then skip to question # 41)</i> | <input type="checkbox"/> | <input type="checkbox"/> | | | |
| | Never | Seldom | Sometimes | Usually | Always |
| 40. I read the message(s) I received from the investigator in response to my message(s). | 1 | 2 | 3 | 4 | 5 |

Overall

| Statement | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree |
|--|--------------------------|-----------------|------------------|--------------|-----------------------|
| 41. I thought the study website was easy to use/navigate. | 1 | 2 | 3 | 4 | 5 |
| 42. I thought the study website was attention grabbing. | 1 | 2 | 3 | 4 | 5 |
| 43. Overall, I thought the study website was easy to understand. | 1 | 2 | 3 | 4 | 5 |
| 44. Overall, I thought the study website was helpful. | 1 | 2 | 3 | 4 | 5 |
| 45. Overall, I actually applied at least some of the strategies and/or information provided via the study website. | 1 | 2 | 3 | 4 | 5 |
| 46. I plan to continue using the strategies and information I gathered from the study website. | 1 | 2 | 3 | 4 | 5 |
| 47. Overall, I was satisfied with the online walking program. | 1 | 2 | 3 | 4 | 5 |
| 48. I would recommend this online walking program to a friend, co-worker, and/or family member. | 1 | 2 | 3 | 4 | 5 |

49. Please list the main barriers/challenges to using the study website that you encountered during the length of the program.

50. Which aspects of the online walking program do you feel helped you the most with your effort to become and stay physically active?

51. What did you dislike about the online walking program?

52. Do you have any suggestions or recommendations related to the improvement of or modifications that should be considered for the online walking program? If so, please list them

Vita

Courtney Monroe is originally from Mt. Zion, Illinois. She attended Bradley University for two years where she played on the intercollegiate softball team before earning her Bachelor of Science Degree in Education (Physical Education with teacher certification and Health Studies with secondary endorsement) at Eastern Illinois University. Then, she earned her Master of Science Degree in Kinesiology and Recreation (Exercise Physiology) at Illinois State University. Upon completion of this degree, Courtney served as a full-time Exercise Science lecturer at Old Dominion University for two years, as well as the Undergraduate Coordinator for the Exercise Science Degree Program during her last year at this institution. While she thoroughly enjoyed engaging in her roles at Old Dominion University and gained valuable experience, she decided to pursue a Doctor of Philosophy degree in Kinesiology and Sport Studies (Exercise Physiology) as a graduate assistant at the University of Tennessee. She has accepted a post-doctoral position in the Department of Exercise Science at the University of South Carolina.